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Loading Hemlock Bark at the Mouth of Bear Creek, Cal. The Bark is Brought Down the Mountain in Sleds and is Then Shipped by Car.

HARVESTING TAN BARK.—[See page 408.]

Prevention of Disease Versus Cost of Living*

Human Life as a National Asset

By Thomas F. Harrington, M.D.

STATED briefly, a normal standard of living may be defined as that which permits each individual to live as an efficient, healthy human being—morally, mentally and physically. This definition simplifies greatly the whole problem of the cost of living and reduces it to a consideration principally of two factors—health and efficiency. All economists to-day agree that the greatest asset of any country is the vital efficiency of its citizens. Moralists and physicians agree that this factor has a direct relationship to morals and to mental efficiency. Furthermore, both assert that the conservation of the physical efficiency aids greatly in conserving the moral and the mental standard of society.

The more c early one sees the whole field of preventive medicine, the stronger the conviction that all the problems are social problems and that they must be solved by social remedies. This is at once evident when we recognize, first, that the responsibility for the conditions that cause these diseases lies with the people and, secondly, that all the power and authority for bettering conditions also rest with society and its agents. It is a popular belief that the control and the prevention of disease are largely a duty of the medical profession. This is not true. The medical profession can and does furnish the technical information as to how disease can be abolished or at least reduced. The physicians can point out the way, but they cannot, of themselves, accomplish anything permanent without public support. This support, this co-operation can come best when the public understands what is needed and why it is necessary. Public education, therefore, becomes an indispensable and a necessary factor in every movement for conserving health.

It adds to rather than detracts from the gifts of Jenner, Pasteur, Koch, Behring and others to assert that their discoveries in medical science were comparatively of small value to humanity until the public was educated in the value and the significance of these wonderful achievements. To-day the results are manifest in the reduction of some diseases almost to nothing, as yellow fever and small-pox; in robbing epidemics, as diphtheria, plague and cholera, of their terrors; n lessening the sufferings and the economic loss in quarantine; and, finally, in developing a happier, healthier, longer-lived community the world over. Each day the force and the wisdom of Pasteur's declaration that no human being need die of a parasitic disease is more appreciated, especially as the public comes to realize the enormous unnecessary waste of health, efficiency, and life itself yet prevailing and due greatly to causes which are preventable.

In reporting on the cost of living, the Massachusetts commission had this to say on this point:

"The increased vital efficiency of the citizens of this State which would result from a conservation of the present waste of health would, if expended in labor, increase the earnings of those whose health is impaired and also lessen the burdens of those who are at present unnecessarily ill. This increase in earnings would thus tend to reduce the cost of living, increase the total earnings of the citizens, and make the average income larger."

The commission asserts positively that there is no direct relation between the waste of health and the recent rise in prices; and furthermore, that there is no evidence that the waste of health lowered the rate of wages. It is very evident, however, that sickness, if long continued or often repeated, lowers the efficiency of the individual, and this lowered efficiency means, sooner or later, a reduced income, often a new and less permanent job. Conservation of health, therefore, means higher wages and this enables the workers to keep ahead of the increasing price of the commodities of life.

The extent to which health may be conserved and the number of accidents and deaths that can be prevented to-day seems incredible. The testimony of all those who are competent to judge agrees that on a very conservative estimate, 42.3 per cent of the deaths each year might be postponed; that at least 50 per cent of the cases of serious illness are preventable; that the average human life is capable of being prolonged 12.3 years; that 4 per cent of the population of Massachusetts are on the sick list all the time, with an average loss, to each individual in the State, of the equivalent of two weeks' wages each year. Stated in dollars and cents, this means that families and the State suffer an annual loss of fifty million dollars because of preventable deaths and preventable serious illness—a per capita loss, each year, of fifteen dollars. This startling unnecessary waste does not include the economic loss of the 12.3 years that are sacrificed to indifference, ignorance, and neglect in applying the lessons which preventive medicine makes possible.

These great unnecessary wastes of human life and efficiency, affecting the cost of our living which are greatly preventable, may be grouped as follows: (1) preventable accidents; (2) preventable illnesses, and (3) preventable deaths.

Under the head of preventable accidents we are rapidly accumulating a mass of testimony the application of which to preventive measures should reduce greatly the risk and hazard of industrial life. Occupations are now being classified on a basis of relative risk to the workers. While it is true that many occupations will always carry with them unavoidable risks, nevertheless it can be claimed, without fear of successful contradiction, that there is not one of these occupations in which the hazard and risk of accident cannot be reduced to a minimum. The reports of the committee of the National Association of Manufacturers and the Interstate Commerce Commission show that in this country there were 500,000 workers incapacitated or killed by accidents incidental to industrial life in one year. The fact that 11,800 persons, employees and others, were killed, and 111,000 mained on our railroads is in striking contrast with the reports from the industries of Germany, where the established facts of preventive medicine are applied. Since July 1st, 1912, there has been in operation in this State a Workmen's Compensation Act. In six months over 52,000 accidents have been reported. The provisions of this act and the exceptionally high personnel of the commission justify a most optimistic view with regard to future prevention of the great loss of health, limb and life. It has been the experience in Germany—and in States in this country—that the adoption of this line of insurance has led to the installation of safety devices by employers which have reduced greatly the number of accidents. In the meantime, much progress can be made by instruction in the prevention and the avoidance of dangers incidental to industrial life.

This is very necessary to-day inasmuch as the trend of public education is toward greater emphasis on vocational training. Children now being guided into the various lines of vocational life should be given a word of warning or caution on its possible dangers. Laws may compel the employers to protect the employee from exposed machinery, from dangerous fumes or irritating dusts, but no law can compel operators in rubber factories, for instance, to wash their hands, or prevent operatives at this work from eating and drinking in the work-room. Neither can laws adequately protect the employee from accident from electricity when this element is a necessary and often unavoidable source of danger. Instruction in prevention is here more important than labor laws for either protection or compensation.

Undoubtedly the three great factors besides ignorance which promote industrial accidents are defective hearing, defective sight and fatigue. Many failures, both in health and in efficiency, are due to poor sight or hearing. Persons with either defect are as clearly out of place at many lines of industrial life as a color-blind person would be as engineer, pilot or color-mixer. Many occupations increase these defects. Accidents must result sooner or later.

One of the immediate results of the application and future extension of the Employers' Insurance and Workmen's Compensation Act must necessarily be that great attention will be directed to those physical defects which tend to increase industrial accidents, especially defects of vision and hearing, a large majority of which defects are remedial and curable.

The influence of the factor of fatigue in causing industrial accidents has not received the attention it deserves. The amount of unnecessary fatigue among all classes is not appreciated. Prof. Fisher states that 5 per cent of all persons in this country are fatigued to a degree sufficient to totally impair their working powers. Every physician, conversant with industrial life in our great manufacturing centers, recognizes the constantly recurring accidents which occur daily in the mills and workshops. These accidents occur with a clock-like regularity at certain hours of the day, a time of the day when the fatigue factor is most active. This fact has been carefully worked out in the German insurance tables and is as follows:

Time.	Accident Per cent.	Time.	Accident Per cent.
6- 7 A. M.	2.82	12-1 P. M.	3.81
7- 8 A. M.	5.16	1-2 P. M.	4.84
8- 9 A. M.	5.29	2-3 P. M.	6.73
9-10 A. M.	6.04	3-4 P. M.	8.07
10-11 A. M.	10.37	4-5 P. M.	7.65
11-12 A. M.	10.31	5-6 P. M.	8.48

From a very intimate knowledge of industrial life in the largest manufac uring city of this State, I have no hesitation in designating fatigue as one of the great factors in accidents of factory life. Fatigue has also a direct bearing on the susceptibility of the individual to disease. It lowers the whole tone of the nervous and muscular systems. It is a great evil not yet sufficiently recognized as a factor in undermining health and efficiency. It can be prevented almost wholly. Fresh air, good ventilation, avoidance of overheated workshops, enforced periods of rest interspersed in daily life, especially at midday, outdoor exercise at noon rather than confinement in vitiated room atmosphere, a more rigid inspection of industrial and mercantile conditions of employment, a strict enforcement of laws relative to hours of labor, especially those relating to women and children, and a proper regard for sanitary and toilet accommodations will reduce almost to zero the evil possibilities arising from fatigue.

PREVENTABLE ILLNESS: (A) OCCUPATIONAL DISEASES.

Besides the accidents incidental to many occupations, certain diseases have become so closely associated with certain lines of industries that they are known as occupational diseases. Some of these industries have been designated as "dangerous trades," and the State Board of Health in this State is enjoined by the Legislature to safeguard in a special manner the health of employees at these trades. Minors under 18 years of age are prohibited from entering certain specified trades of this group. Already the board of health has designated some twenty-six of these as dangerous trades, into which minors must not be permitted to enter. The list includes many trades which the educational authorities in several States are incorporating to-day into their programmes for vocational training, as well as for industrial and trade-school work. Educational authorities have a great responsibility added to their strictly pedagogic functions by reason of this fact. A knowledge of these dangers should form a part of the preparation of those who are to undertake the teaching of trades in the public schools. Preventive medicine has pointed out ways and means which, if employed, will reduce to a minimum many of the dangers arising from these trades. It has designated certain family and individual traits which predispose to the development of definite diseases if the person is subjected to employment at specified trades or vocations. The disregard of this "tendency to diseases" explains the occurrence of many physical breakdowns in industrial life.

There are other trades in the pursuit of which physical incapacity is almost unavoidable. Examples of this group include woodcarving, lighography, typesetting, as well as the work of copperplate engravers, designers, photographic retouchers, goldsmiths, diamond-cutters, jewelers and needlewomen, especially those who work at embroidery. Obviously none with defective eyesight should enter these trades. In certain other trades, such as electric iron-welding, glass-blowing, etc., the dazzling rays of excessive light promote the formation of cataract. In trades in which lead, arsenic, phosphorus, methyl alcohol, nicotin, nitrobenzol, etc., are used, the occurrence of skin affections, eye affections, neuritis, paralysis, bone diseases, kidney diseases and blood diseases is so constant that no one to-day questions the cause. Preventive medicine has been able to reduce these dangers greatly, principally by adequate ventilation and light, and by instruction. It would take us too far to enter into the various manifestations of occupational diseases. Sufficient has been given, however, to warrant the suggestion that preventive medicine must form a part, and not an inconsiderable part, in any plan of industrial education or vocational training if the workers are to acquire and retain their best efficiency and health.

PREVENTABLE ILLNESS: (B) GENERAL DISEASES.

It has already been pointed out that fully 50 per cent of illness is preventable. It is no exaggeration to state that if all easily preventable physical troubles were prevented, the addition which would be made thereby to the energy and happiness of the people is beyond description. This item is an additional gain in the family budget—the usual index of the cost of living. Not only has preventive medicine pointed out what

* Address given under the auspices of Council on Health and Public Instruction of the American Medical Association before the Women's Municipal League, Boston, and published in the *Journal* of the Association.

diseases are preventable and how to prevent them, but also it has clearly grouped disease, both as to individual and to class, so that predisposition and immunity each has a vital value. The money value of preventable illness in Massachusetts is, including loss of wages and cost of medical attendance, $14,896,912 each year. This great loss occurs in the wage-earning period of life. It is the one factor often in the cost of living which, if transferred to the asset or credit column of the family, would mean an individual or family added to the class of producers with efficiency and one less in the group of dependents with inefficiency. The results achieved in the fight against tuberculosis are not unique in preventive medicine. Reduction in the morbidity, as well as in the mortality, of other diseases is equally striking and encouraging. The value of the lessons of the anti-tuberculosis crusade lies greatly in the fact that the public is now convinced that the once dreaded foes to humanity no longer possess the terror of former times; furthermore, that it is possible to win a victory over inheritance, environment, disease and even death by the observance of the simplest teachings of preventive medicine, especially those on cleanliness, exercise and diet; also that the effective remedies often are sole'y Nature's gifts—fresh air, sunshine and rest. It is becoming more evident each day that the weapons so effective against tuberculosis are equally effective in combating many other infectious diseases, as well as in eradicating those nervous and functional disturbances which are productive of ill health. While it is unquestionably true that enhanced prices of food have affected injuriously the health of many in the community, nevertheless it is far more evident that the real cause is often an unwise expenditure of the income for articles of food and, more evident still, an improper preparation of food rather than a question of quantity or quality of food or size of income even.

Educational authorities have grasped this fact and to-day great emphasis is being laid on this form of instruction to those who in a few years will be the housewives of the community. This brings the problem of prevention of disease and the cost of living back to the schoolroom. Here lies the greatest opportunity for teaching the value of health and efficiency rather than trying later in life to reduce the cost of neglect of this instruction. The two terms "value" and "cost" are not synonyms.

A good illustration of this fact is the prevalence of heart-disease. It outranks tuberculosis, pneumonia and infant mortality as a cause of death in Massachusetts. It has no equal as a cause of impaired efficiency. It is alarmingly common among schoolchildren. All physicians agree that there is a great difference between a cardiac lesion and a diseased heart. No matter what the anatomic change present may be, that heart is not a diseased heart so long as it can adequately take care of the demands placed on it by the individual. Although this is all true, nevertheless the great value of treatment in heart-affections is that of prophylaxis or prevention, rather than therapeutic or cure. This latter is the cost of negligence in applying prevention. So long as the cardiac lesion can be prevented from becoming an inadequate or incompetent heart, all goes well no matter how serious or of what form the changes in the valves or heart-muscles may be. The enormously high death-rate from heart-disease to-day and the great frequency with which children at the school age exhibit genuine heart-disease, often beyond a possible stage of competency adequate for the simplest vocations of life, make this problem one of the most important in political economy.

Eliminating the heart diseases of those congenitally defective, who seldom reach the wage-earning period, it can be claimed that fully 80 per cent of heart-disease could be prevented if the initial lesion and the exciting cause of the lesion were treated with half the care that is now given to the same stage of incipient tuberculosis. Preventive medicine teaches that rheumatism (often called growing pains), tonsillitis, chorea (St. Vitus' dance), diphtheria, scarlet fever, as well as the various infectious diseases, cause a large percentage of heart-disease each. Some of these heart-affections are unavoidable. Many, however, are preventable if anticipated early.

Next in importance to heart-disease prevention is the problem of prevention of diseases of infancy and of childhood. The necessity, as well as the importance, of beginning this prevention early in life is shown by the single fact that one third of all cases of blindness can be referred to infection and neglect at the time of birth. These sightless babies soon become a burden on the family and subtract much from the possible income by the home care required from wage-earning mothers. Much infection of eyes, nose, mouth, etc., of the newborn can be avoided by the observance of the simple rule in preventive medicine—cleanliness.

Infant morbidity and infant mortality as recorded to-day are a gross injustice to mankind, neither excusable nor pardonable. It is little short of criminal negligence that permits them to exist. That they represent the greatest loss to mankind to-day is the verdict of all economists. To state that one fifth of all deaths that occur each year are those of infants less than one year of age, and that one fourth of all deaths are those of children less than five years of age, while appalling, does not half state the situation. Our present knowledge of sanitary measures guarantees readily that 47 per cent of those who die during the first year of life could be saved, and that 67 per cent of the diseases that kill in the first five years of life are preventable. Notwithstanding this possible prevention, more than 200,000 of these young lives are sacrificed each year in this country at the rate of one life each ten seconds of time. Nothing so contradicts our boasted civilization and our claim of modern advance in medical science as this yearly unnecessary waste of infant life. At times it would seem, from the apparent indifference shown in the matter, as if the public yet believed that this high rate of mortality among children at or soon after birth was a wise dispensation of Nature to eliminate the unfit. In a study of this problem, it becomes evident that almost one third of these deaths, especially of children under one year of age, can be ascribed to diseases of the digestive system. These diseases, together with those of the respiratory system and congenital debility, carry off 70 per cent of all babies who die in the first year of life. This reduces the problem of prevention to simply giving to the baby its natural birthright, namely, the right to be born healthy, and secondly, pure milk and pure air, or, as it is more generally stated, proper feeding.

The noble, patriotic, unselfish warfare that this association has waged for a purer and better milk-supply in our city has won the admiration of all who put a value on human life above that of commercial interests. No physician questions the benefit of this factor in reducing infant illnesses and deaths in many cases in which this form of artificial feeding has, through necessity, been adopted. The problem that I would present, however, is not so much that of the quality of cow's milk as an article of food, but whether it should be advocated as an adequate or preferred substitute for natural breast-feeding. I do not think it is. Undoubtedly, the high cost of living has forced many women to seek employment outside the home in order to help out the family income, and a large sacrifice of life, prenatal as well as infant, has resulted. Many infants, even when born healthy, are sacrificed by either the inability or the unwillingness of mothers to nurse their offspring. The question of infant morbidity and infant mortality is not one of sanitation alone, or of housing, or of poverty as such, but is mainly a question of motherhood. The problem will be solved only when the value of intelligent motherhood is placed above that of philanthropy, of hospitals, of the medical profession and of the State. Neglect and ignorance are, therefore, more important than poverty as causative factors in the cause of infant illness and deaths. We have two striking illustrations bearing directly on this point.

During the siege of Paris (1870-71) the women were compelled to nurse their own babies on account of the absence of cow's milk. Infant mortality under one year fell from 33 to 7 per cent.

During the cotton famine of 1860 women were not at work in the mills. They nursed their babies and one half of the infant mortality disappeared.

From 80 to 90 per cent of all deaths from gastro-intestinal disease among infants takes place in the artificially fed, or ten bottle-fed babies die to one which is breast-fed. In institutions it has been found that the death rate is frequently from 90 to 100 per cent when babies are separated from their mothers. After a trial of fifteen years, by which over 7,000 mothers with their babies were placed out in domestic service, the New York society was able to report that four fifths of the babies lived and were in good condition; one fifth died or were in poor condition.

The subject of infant-feeding, therefore, is not to be treated as an ethical question alone, but must be considered as a problem of preventive medicine of far-reaching results. It is an undisputed fact of preventive medicine that certain vital tendencies, which make for the preservation of the infant, such as immunity against certain infectious diseases, are transmitted through the mother's milk to her child. Neither a wet-nurse's breast-milk nor a cow's milk can do this for a child.

There are, unfortunately, a large class of women who cannot nurse their infants, but medical experience the world over fails to substantiate the popular belief that failure to nurse the children is due to weakness in the mothers. The decrease in the proportion of breast-fed children is due, first, to more frequent occupation to-day of wife and mother outside the home; second, to the exaggerated claims of artificial food manufacturers, and the popular delusion that their adaptation to the physiologic needs of each infant is so simple that the process can be safely entrusted to "little mothers" who, after one or two lessons, can accomplish what the highest trained clinicians, working under ideal conditions of cleanliness and sanitation, fail to attain. Modern dress and modern social life have combined as factors in reducing the proportion of breast-fed infants. Whether these factors will collect their toll on the next generation of daughters remains to be seen. A recent investigation showed that only two daughters, out of 480 born to mothers who could not nurse their children, were themselves able to nurse.

The much-heralded influence of poverty, overcrowding and poor housing conditions as factors in infant mortality does not accord with facts. Whatever influence any one of these conditions might possess is greatly minimized by the favorable effects of breast-feeding and, as pointed out in the beginning, by the purchase, so to speak, of our hygienic advantage by a hygienic sacrifice in another direction. The truth of this is evident from a study of our own local situation. Boston has the lowest deathrate of infants under one year of age of any city in the country. Ward 8 has 190 persons to the acre, the most thickly settled part of Boston; yet it is next to the best ward, so far as infant mortality goes, and only fourth in the total mortality of the city. Ward 10, the sixth most congested district in the city, has the lowest general mortality as well as the lowest infant mortality in the city. The highest total mortality occurs in Ward 7, which has only 38 persons to the acre. Ward 5, with a density of 62, and Ward 13, with a density of 35, stand quite high in the rate of mortality each year. These same general results can be quoted from many cities of foreign countries. The conclusions from the study of the problem in the most insanitary districts of Italy are that the low infant mortality prevailing in many of these districts is due to the custom of breast-feeding followed by the poor people. In many cities of Germany and Austria the law requires the death certificates of infants shall contain a statement of the kind of food given to the infant either shortly before its death or throughout its life. There is no legitimate reason why the use of artificial foods and of so-called milk substitutes for infant-feeding should not be controlled by law and their use limited to the prescription of a physician. Such a law would reduce greatly infant morbidity and infant mortality.

I have dwelt at some length on the problem of infant morbidity and mortality because it is one of the greatest preventable wastes of life to-day, and one that weighs most heavily on the family budget. It resolves itself chiefly into a question of proper feeding. This is best guaranteed by intelligent motherhood, which can alone give to the infant that which neither wealth nor State nor yet science can offer with equal benefit to mother and child.

Many lessons of the value of preventive medicine in solving the complex problems of the cost of living might be presented in addition to those given here. I have selected the more prominent and the more evident of the group. There are others equally important.

The fact to remember is that the whole problem is a social one. Increased cost of living is not likely to be lessened or altered by laws or mode of life. Such remedies are largely academic. Preventive medicine does offer a cure for the condition in part at least if not in its entirety. It shows how the enormous waste of health, energy, money and life may be curtailed and greatly prevented. It guarantees to each person who will learn its lessons and who will apply even its simplest teachings an assurance of greater power, greater health, greater wage-earning ability. This means a nearer approach to the normal living standard of each individual—an efficient, healthy mode of life—physically, mentally and morally.

The Scarcity of Capital

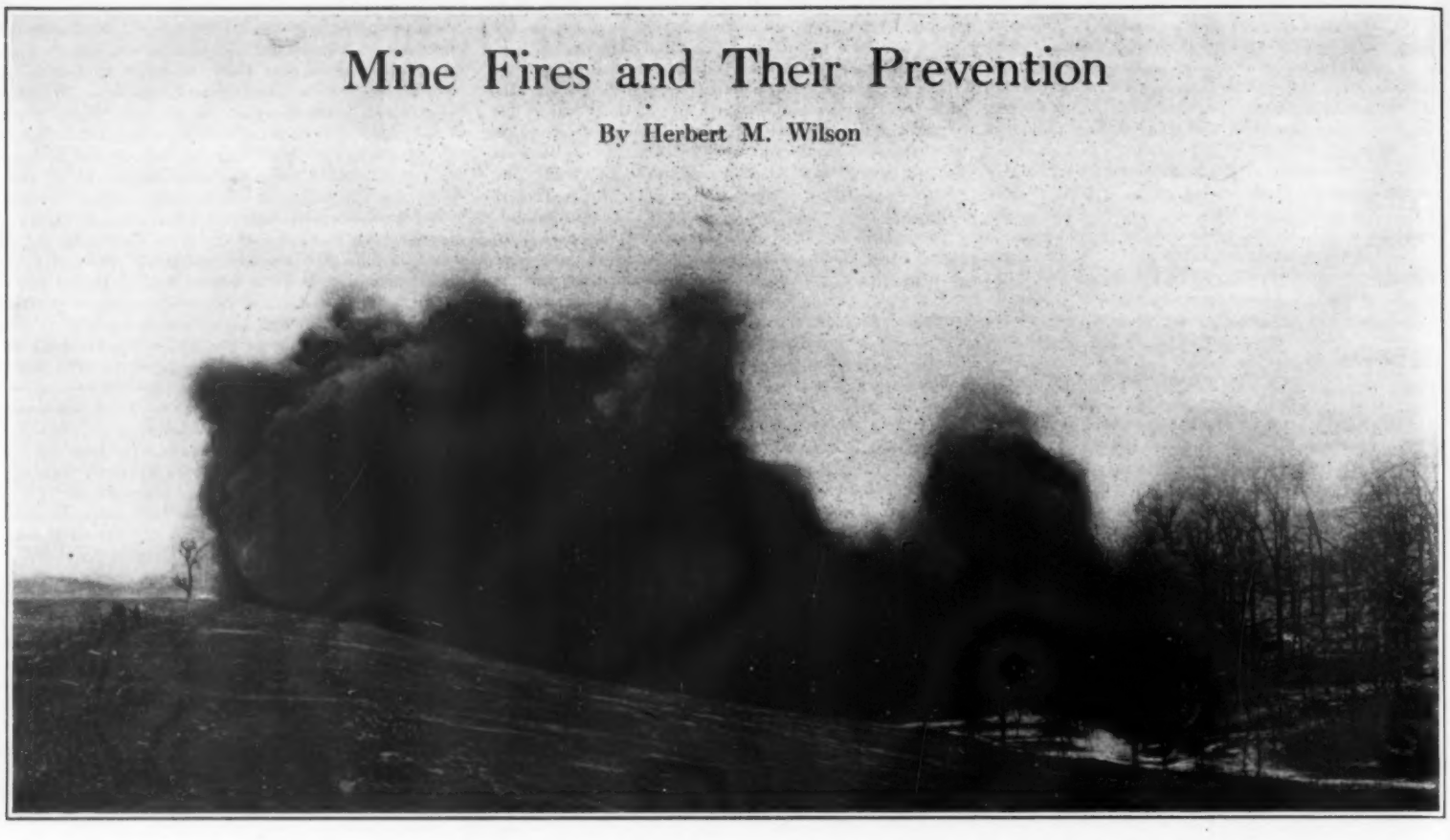
THE following quotation from the *New York Evening Sun* is well worthy of the consideration of all those who take an intelligent scientific interest in economics and particularly in the prevailing economic conditions:

"The amount of capital available in the world to be borrowed and spent is at any given time a definite quantity which cannot be increased by any scheme to reform currency or promote the efficiency of banking.

"Therefore if a lot of capital is borrowed and spent in unproductive ways there will be not only less for other uses, but the natural growth of capital will be arrested in proportion as the uses to which it is devoted are unproductive. When you put $10,000,000 of capital into an industry or a railroad it multiplies itself; when you put capital into armament, meaning warship and standing armies, as has been done on so vast a scale in Europe, or when you spend it on monuments which in themselves have no earning power, as has been done widely in this country, the capital is, in the economic sense, lost. It cannot multiply. The enormous expenditure of capital all over the world in unproductive ways is the fundamental explanation of the present scarcity of capital."

Mine Fires and Their Prevention

By Herbert M. Wilson



MINE fires are more frequent of occurrence and more destructive of property than are explosions, and take nearly as great a toll of life. It is an unfortunate commentary on the foresight of the people that some great holocaust, as the Monongah mine explosion, or the Cherry mine fire, is necessary to arouse a sense of the dangers and cause a search for the remedies. As the Monongah, Darr and Naomi mine disasters of 1907 brought forth the Federal Bureau of Mines with its resultant tests of permissible explosives, investigations of explosibility of coal dust, and a generally aroused public sentiment which has reduced the frequency of great explosion; so the Cherry mine fire aroused the country to the extent of the fire hazard in mines, and has set in motion efforts already showing important results toward the prevention of fires in mines and the protection of mines from fires.

Fires in an anthracite mine near Carbondale, Pa., have raged for ten years and still rage with resulting destruction of underground and surface property. There has been destroyed $25,000,000 worth of coal in the past five years in a mine fire still burning near Summit Hill, Pa. The mine fire at Cherry, Ill., and the Pancoast mine fire near Scranton, Pa., have recently been most destructive to life.

Fires in mines are not, however, confined only to coal mines, but have been almost equally destructive in metal mines. Fires have been raging in the deep mines of the Anaconda Company at Butte, Mont., among the old timbers since 1889, and for many years in the Comstock vein in Nevada thousands of feet of timber were burned out with consequent caving of roof, dislocation of metal-bearing vein, and loss of ore. A million dollars has been spent in fighting a metal fire at the Homestead mine at Deadwood, S. D., and there has been great loss of life in recent fires in metal mines at Tonopah, Nev., and Copper Hill, Tenn.

But more shocking than all is the fact evidenced by the record that the greater number of these disastrous fires had their origin in trivial causes and, had proper safety regulations been in force, proper means been at hand for fighting fires, and reasonable practice and enforcement of the rules been had, these fires might have been quickly extinguished. This subject of careless and preventable fires is one regarding which I cannot speak too strongly. Your attention, and that of all concerned in mine regulations and management, should be fixed and held by the distinction between fire prevention, which is recommended as a slogan, and fire protection, which is vastly more expensive in the long run and concerns only the abatement of the evil after fire has been given lodgment. Fire prevention with reasonable protection will go a long way toward reducing the enormous waste in life and property resulting from mine fires.

Those who are concerned in operating mines and directing village governments in mining towns, should adopt systems of fire inspection and of fire protection, clearly separating the agencies for fire prevention from those of fire fighting. The careless and preventable fire might soon become a memory of the past, were the school children in mining towns, and the miners themselves taught, as is done in the schools of Ohio, the dangers in the careless use of non-safety matches, the throwing away of cigarettes, lighted candle stumps, lamp wicks, the danger in handling inflammables, lubricants, and greasy waste, in other words, all uncleanliness.

The first precaution toward fire prevention is, therefore, not only rules and regulations, but a firm and consistent enforcement of them by mine officials and State authorities. So, too, a large measure of prevention will be furnished by proper drills to test the condition of preparedness.

Reviewing recent activity toward solving the mine fire problem, we find first the admirable laws enacted in the State of Illinois, March, 1910, and June, 1911. These provide a model statute for the guidance of other States, relating especially to fire fighting equipment and preventive measures. Much in the way of detail yet remains to be worked out regarding fire-proof construction. In May, 1911, the powerful organization known as the National Fire Protection Association, appointed a special committee on mine fires, the personnel of which includes a number of prominent mining engineers and fire protection engineers representing various portions of the country. This committee presented a preliminary report in 1912, which outlines rather clearly those topics which can best be investigated by State and Federal bureaus and those which can best be handled by the mine operators. The United States Bureau of Mines issued in 1912, a preliminary

*Address before the Mining and Fuel Conference at Urbana, Ill.

Ready to Fight the Flames and Smoke. A Gang of Rescuers at a Mine.

Waiting for Friends and Relatives at the Mine Entrance. Scene from the Cincinnati Mine Explosion, April 30th, 1913.

circular concerning mine fires and how to fight them, which was followed shortly by a technical paper, constituting a preliminary study of mine fires.

Meanwhile, the mining industry has not been idle. There are many mines in this country and abroad where fire rules are posted in the mining towns, in the office, and in the mines. Adequate water supply, reel and hose, are provided for protection of surface structures. There has been great activity in the last decade in the replacement of inflammable mine buildings, and especially head houses and tipples, by steel or other non-inflammable construction. Underground, too, in a number of cases, shafts, tunnels and main haulage ways, as well as stables and other danger points, are being lined with fire resistant construction, and reasonable care is being exercised in the handling of the material, in preventive measures, and in provision of fire fighting appliances.

So far papers on mine fires in technical journals, the preliminary bulletins of the Bureau of Mines and the bulk of the State laws are all concerned with fire fighting and protection against carelessness.

Little consideration has been given in technical literature to the more permanent and effective preventive measure of fire-proof construction. The second of the recent Illinois laws, that of June, 1911, devotes several sections to this most important subject. It limits the conditions under which inflammable construction may be used in mine stables, it details fireproofing measures necessary in and about the stables, the hay and feed storage receptacles, and directs that hoisting shaft and air escapement shaft shall be of fire-proof construction, as well as roofs, walls and passage ways, leading from the bottom of the hoisting shaft.

This is a long step in the right direction, but lacks details. These are pointed out in some measure in the last annual report of the Committee on Mine Fires of the National Fire Protection Association. This report deals first with the surface plant which should be capable of the same treatment as other surface industrial plants; it recommends that all mine openings should unquestionably be non-combustible and be protected, preferably by automatic sprinklers; it classifies building materials, their conditions as to combustibility; recommends that no inflammables be permitted within 100 feet of mine opening; suggests the character and amount of water supplies, and the grouping of buildings depending on inflammability, and takes up the question of special devices for preventing spread of fires from the surface to underground workings. It next takes up the mine openings and the importance of making them incombustible. Finally, in underground works, it suggests classification of linings, timbering, overcasts and stoppings, by their fire resistance.

There has been developed in recent years a large volume of detailed information concerning methods and costs of permanent underground construction. As long as fifty years ago a steel shaft lining was placed in the Shieroaks Colliery, England, and this is reported still to be in good condition. Steel props and lagging have been in use in England in the Norfolk mine since 1885. Structural steel sets were perhaps used in the United States first in 1897 by the Susquehanna Coal Company, of Manticoke, Pa. At an early date brick linings, as to shaft and tunnels, were introduced in Europe, and more recently in this country. Still more recently concrete and reinforced concrete linings, mine posts, beams and timber sets have been adopted.

Taking up the shaft lining, this should unquestionably be of fire-proof construction. It may be of brick, of monolithic, or reinforced concrete, or of structural steel backed by steel lagging or reinforced concrete slab or curtain wall, as local conditions, availability of materials, and cost may indicate. Numerous admirable examples are available to the designer for shafts of circular, elliptical, and rectangular cross sections. These have been constructed in the metal mines in Nevada, Montana, Michigan and elsewhere, as well as in coal mines from Colorado to Pennsylvania.

In like manner there are many instances throughout this country, and innumerable ones abroad where the roof and walls of the passageways leading from the bottom of the hoisting shaft and escapement shaft are of fire-proof construction. These, like shafts, are usually lined with brick, reinforced concrete, or steel timber sets supporting non-combustible lagging.

It will be a long time ere wooden mine timbers are displaced to any appreciable extent by those of metal or reinforced concrete. Yet the endeavor should be constantly to bring about this substitution, not only on account of greater protection from fire, but also because of greater permanency in construction and consequent ultimate less cost.

But of all the elements in the mine, the stable or the underground engine room should demand first attention. I have seen several examples of excellent and cheap fire-proof construction in stables in the coal mines of Pennsylvania, and elsewhere. Old iron pipe of small diameter furnishes excellent structural material for posts and partitions separating stalls. For sanitary reasons and the preservation of the health and efficiency of the animals, wooden floors should be furnished in a portion of the stalls, but these should be so laid in concrete as to render them slow burning, if not fireproof. The laws of Illinois require separating a limited number of stalls by fire-proof partitions, and require the provision of fire-proof storage places for hay and other inflammables. Such stables should furnish at a minimum ultimate expenditure the maximum of protection.

Returning to the shaft and main haulage way: there is a large field for experimental work in the design and construction of these in concrete, the cost of which shall be kept at a minimum by the use of local mine rock and refuse as aggregate. Where considerable pressure is to be resisted the best materials, mixed and laid in the most approved manner, are essential. Nevertheless, there are many mines where the essential is rather protection from seepage and inflammability, and where a minimum of compressive strength will suffice. Under such circumstances mine rock and other mine waste, sand or other fines locally available may greatly reduce the cost of material.

The following compressive tests were made by the engineers of the Bureau of Mines on large sized cubes of concrete made with mine rock, culm, ashes, sand, and gravel gathered in and about the anthracite mines of Pennsylvania. The proportion of cement used was very low in order to secure results on the cheapest mixtures. These tests are compared with the best average results procured with rich concrete of furnace cinders and the best river sand and gravel, viz., 1 cement, 3 anthracite cinders and 6 breaker refuse, 425 pounds per square inch; 1 cement and 7 anthracite culm, 430 pounds per square inch; 1 cement, 3 sand and 7 breaker refuse, 455 pounds per square inch; 1 cement, 3 sand and 7 mine rock, 594 pounds per square inch. Compare these results with: 1 cement, 2 sand and 5 cinders, 1,300 pounds per square inch, and 1 cement, 2 sand and 4 gravel, 4,600 pounds per square inch.

With proper preliminary designing, it may be possible to keep in stock a few permanent forms for molding concrete. With such forms, shafts and tunnels can be more cheaply constructed after the manner in which concrete sewers and water supply tunnels for cities are now built. There is abundant published data regarding the cost per linear foot of permanent and non-inflammable shaft and entry lining, showing, in many cases, that in a period of, say, ten or fifteen years such lining is measurably cheaper than timber lining, which latter may have to be renewed several times in the same period.

Probably no portion of a coal mine should be so carefully constructed as stoppings and overcasts. Here concrete has the advantage over timber, because of the less resistance to air currents and the great importance of having them fire-proof.

With mine timbers, as with shaft and entry linings, there are many excellent examples reported in detail where steel and where reinforced concrete have been used to replace wooden timbers. The mine timber problem is one of the most urgent confronting the mine operator. The forests of the United States are rapidly disappearing and the cost of timber is rapidly increasing until a point has been reached for may forms of construction where in these portions of the country most distant from timber resources either steel or reinforced concrete is cheaper even at the first cost. In many wet mines wooden timbers have to be renewed every three years. Steel and concrete timbers may last indefinitely. Wooden sets, according to their dimensions, may cost, in place, ten to thirty dollars, more or less, though there are records of steel sets costing about the same sum under similar conditions, whereas after a period of fifteen years the permanent timbering will have cost one third or one fourth the price of the wooden sets. Reinforced concrete is not well adapted to mine timbers, especially when laid in place, because of the difficulty in placing forms and pouring, and the slowness in setting and in developing maximum resistance. Such timbers have, however, been satisfactorily molded and seasoned in required lengths in the open and then conveyed underground and placed much as are wooden timbers.

Steel timbers may be of many forms; "H" and "I" beam forms being more common. There is a record of a mine in France where steel props after having been deflected by weight of the overburden, have been pulled and straightened out and roused as often as one or two hundred times. Form of metal mine post recently adopted in Belgium consists of old light metal pipe filled a portion of the way with compressed peat; on top of that a packing of coal dust and broken stone; and above all a short wooden plunger. The effect is to produce a telescoping prop which gives gradually under the roof pressures.

There is every reason to anticipate with confidence that the time is rapidly approaching when, due not only to an awakened public sentiment demanding greater safety in mines, and in some measure also because of the greater safety demanded by the enactment of workmen's compensation laws, but more especially because of the relatively increasing cost of wooden timbers, as compared with metal and concrete and the greater permanency of the latter, fireproof construction within our mines will henceforth rapidly supercede the more prevalent inflammable construction.

In justice to the American mine operator it should be said that while the price of nearly every other commodity has risen rapidly in the last fifteen or twenty years, the price of coal at the mine has hardly increased one cent per ton. It is not reasonable to expect great expenditures in safety measures and in permanent and fire resistant construction when the price which may be had for coal at the mine is such that many operations are run at little or no profit to the owners.

Mine Fires Frequently Start in the Stables. Concrete Construction Minimizes This Danger.

Warning Sign at Entrance to a Dangerous Spot in the Mine.

The Formation and Structure of the German Potash Beds*

Deposits of High Economic Value and Peculiar Geological Interest

By Prof. Dr. H. Boeke

In Central Germany the Permian strata consist, not of the usual material of sedimentary rocks (clay, sand, lime), but of soluble salts; calcium sulphate (in the form of gypsum or anhydrite), rock salt, potassium and magnesium salts. Especially the last two, are very unusual constituents of the earth's crusts, and the potash deposits of this district are of the highest economic importance to the country, owing to the value of potash as artificial fertilizer. Since their discovery about fifty years ago, these potash deposits have formed an important source of German industrial prosperity. Let us begin by considering first of all the general mode of formation of these readily soluble rock formation.

The salts which have been enumerated are the same as those which are at the present day found in solution in sea water, and the assumption seems warranted that sea water in Permian times, from which the potash salt deposits in Germany were laid down, had a similar composition as sea water of to-day. The following is the composition of the solid residue, amounting to about 3.5 per cent of the total weight, of sea water in our ocean to-day:

Sodium	30.45	per cent
Potassium	1.125	"
Magnesium	3.69	"
Calcium	1.18	"
Chlorine	55.29	"
Bromine	0.185	"
Sulphuric acid	7.76	"
Carbon dioxide	0.20	"
Total	99.88	per cent

An arm of sea had become cut off from the main ocean so as to form an inland salt lake, and its evaporation caused the deposition of the salts mentioned, to a thickness of 2,000 to 2,500 feet. At the point where the potash deposits were first discovered, in the neighborhood of Stassurt, the deposit shows a fairly regular succession of layers of different compositions. Generally speaking the materials increase in solubility from below upward. According to the theory developed by J. Walther, a large inland sea covering the greater part of Modern Europe, was cut off from the ocean in the earlier Permian epoch. The boundaries of this sea are indicated approximately as running along the Ural Mountains, the present site of the plain of the Danube, Ireland, and the Scandinavian Mountains. At that time a desert climate prevailed, and this inland sea gradually evaporated and shrank, until its last remains were completely dried up in central Germany. There the concentrated mother liquors separated out in large quantities, while at the more marginal regions the less valuable, salts such as gypsum and anhydrite, as well as the large excess of rock salt, were deposited in considerable quantities. Probably streams and rivers further helped to carry the salt from the marginal regions toward the central basin.

Walther's theory gives us an explanation of how it was possible for an organically connected region of salt deposit to form in northern and central Germany, surrounded by more or less isolated, smaller potash deposits as at Inowrazlaw on the Polish frontier, and in other eastern parts of the low lands. While the actual distribution of potash salts over this entire region is as yet somewhat uncertain (it may be very extended), as a matter of fact at the present day only the restricted area around the Harz Mountains and the Thüringer forest are of commercial interest.

The particular conditions which were required to cause the abundant deposition of potash salt, seem, so far as we can tell at the present time, to have occurred only once in the whole history of the earth's crust, and only in one place, in Germany of to-day. It is true that quite recently there have been discovered in the tertiary strata also, potash salt deposits, as for instance in Alsace and in the Rhine country north of Bâle. But it is very probable that these cases represent merely local recrystallizations from previous deposits of Permian origin.

During the first one or two decades after the discovery of the potash-salt deposits, scientific men paid little attention to this remarkable formation. The reason for this was probably that the methods employed hitherto in the study of geology were not adequate to deal with this case. The course of the crystallization of so complicated a solution as that represented by sea water is a chemical problem that can be solved by the methods peculiar to this branch of science. Now a problem of this sort may be attacked in two ways, which we may distinguish as the analytical and the synthetical, respectively. The analytical method consists in allowing a sample of sea water to evaporate and determining the nature of the successive deposits which are formed as evaporation proceeds. Investigations of this sort were carried out as early as 1849 by the French savant, Usiglio. It became apparent, however, that the problem could not be solved in such simple manner. Just as soon as the liquor has become viscid by the evaporation of the main portion of the water, crystallization is much impeded, and the several substances separating out are difficult to identify, so that it becomes difficult or impossible to determine the equilibria between the solution and the crystallization products.

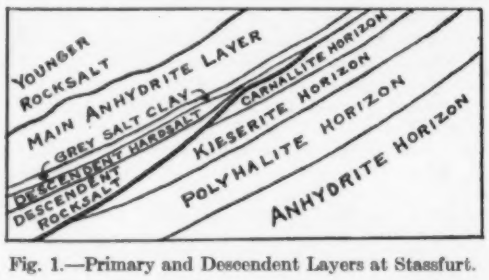


Fig. 1.—Primary and Descendent Layers at Stassfurt.

An entirely different method was applied to the study of the problem in the year 1896 by van't Hoff. Starting out from simple solutions of sodium chloride and potassium chloride in water, and working under precisely defined conditions of temperature and composition, further pertinent constituents were gradually added, and thus the laws of the crystallization of the salts contained in sea water, when present in any proportion, and at any temperature, were determined. Natural sea water in this course of investigation represented merely one special case within the scope of the study. We cannot here enter into details of the methods employed and results reached in a research extending over some twelve years, and carried out with the collaboration of some thirty chemists. We must restrict ourselves here to a consideration of van't Hoff's work on the potash deposits.

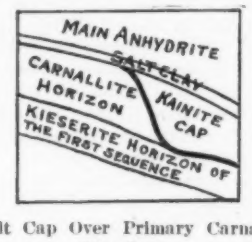


Fig. 2.—Salt Cap Over Primary Carnallite Near Stassfurt.

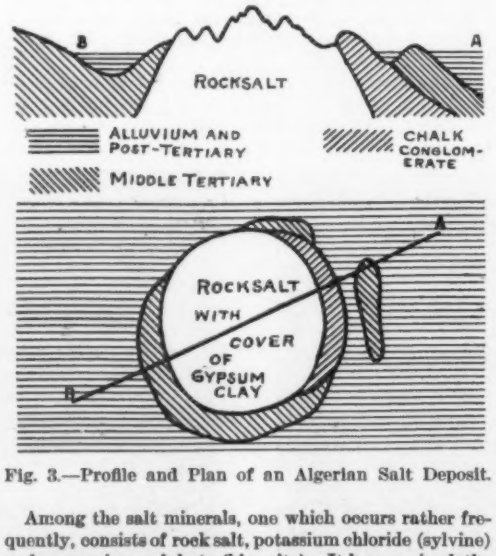


Fig. 3.—Profile and Plan of an Algerian Salt Deposit.

Among the salt minerals, one which occurs rather frequently, consists of rock salt, potassium chloride (sylvine) and magnesium sulphate (kieserite). It has received the German name Hartsalz (hardsalt) owing to the hardness of the kieserite. Now, it has been found that this combination of salts can deposit from aqueous solution only at a temperature of 72 deg. Cent. (162 deg. Fahr.). At lower temperatures potassium chloride and magnesium sulphate come down together in the form of a double salt known as kainite. Geologists were much averse to accepting the supposition of such a high temperature of formation for the deposit in question, and probably no question in the geology of the salt deposits has given rise to more lively discussion than this. To the present day the question remains unsettled.

It is only after the formation of the potash-salt deposits had been investigated by inductive theoretical methods, that the study of the natural formation of these strata, could, with any hope of success be attacked. It is a remarkable fact that in this branch of science inductive investigation preceded a precise description of the natural conditions, a sequence of events which is quite unusual in the historical development of most branches of science. It was soon discovered that the salt deposits occur in their original primary conditions only in a small district between the Harz Mountains and the Flechting range near Madgeburg. The fundamental stratum here consists of a layer 1,000 to 1,600 feet in thickness, consisting of rock salt with about 4 per cent of calcium sulphate, laid down with great regularity in the so-called Year-rings. This formation is known as the anhydrite horizon. Above this are layers, containing in addition to rock salt, compounds of magnesium and potassium, the so-called mother-lye salt. There is first a layer of about 130 feet thickness containing the rather difficult soluble polyhalite, then a layer of about the same thickness with Kieserite and lastly the carnallite with its 16 per cent contents of potassium chloride, a very important layer. The deposit in this region consists of about 60 per cent carnallite, KC1, NaC1, $6H_2O$, 20 per cent rock salt and 20 per cent kieserite. Especially the first of these bodies (carnallite), is very soluble. In fact it takes up water from moist air and deliquesces. It is, therefore, not surprising if soon after the separation of the carnallite, still within Permian times, deposits became redissolved and recrystallized at many points. Such metamorphosed deposits are commonly spoken of as descendent, according to Everding. Such descendent salt deposits according to the modern view form the greater part of the German salt deposits and are the favorite type of deposits for commerical exploitation, on account of the small percentage of worthless magnesium chlorides in them.

Above the primary and descendent salts there is found throughout the potash-salt region, clay layer measuring from 13 to 33 feet in thickness, which has protected the salt from becoming redissolved in water that might otherwise have reached it from above. The cause of this deposit of clay is not yet fully established, but a portion of it at any rate must have been wind wafted. After the deposition of this gray salt clay, the crystallization of calcium sulphate (anhydrite) and of rock salt began anew, accompanied here and there by potash salts, especially at those points where the younger salt deposits are thickest, in the neighborhood of Hanover. Then the deposition of salts was again interrupted by the laying down of a stratum of clay. After this deposit came another layer of 116 feet of rock salt, till finally the desert waste of the Bunter put an end to the further deposition of salt.

In the course of time as the strata of the mesozoic age were deposited over the Permian layers, these latter were submerged deeper and deeper below the surface of the earth. As is well known the temperature below the earth's surface rises by about 1 deg. Cent. for every 100 feet of added depth. In many places there must have been as many as 1,600 or 1,700 feet of younger strata deposited over the German potash-salt deposits, which would correspond to a temperature of about 150 deg. Cent. in excess of that at the earth's surface. Now the salt minerals which we are considering, especially carnallite, containing as they do a high percentage of water of crystallization, represent systems highly capable of chemical transformation, and it is probable that the carnallite mineral, owing to the rise in temperature which occurs, was at times converted into a semi-fluid or pasty condition, in which its natural stratification became obliterated. In the subsequent cooling as the overlying strata were removed by erosion, the mass became consolidated to a rocky material containing fragments of rock salt and kieserite inclosed in a carnallitic matrix. These explanations, which are due particularly to Arrhenius, account for the fact that the "hard salt" (which contains no carnallite) has remained clearly stratified, although in direct contact with the carnallitic mineral which displays the peculiarity indicated above.

Toward the end of the mesozoic and during tertiary times Germany became subject to considerable geologic upheavals. The lower layers were folded up into arches and were brought nearer to the surface through erosion at the earth's surface of the overlying strata. To this circumstance we owe the fortunate fact that the potash salts at the present day lie at a depth accessible to mining operations. But wherever the salt reached within about

* Translated for the Scientific American Supplement from *Die Umschau*.

a thousand feet of the surface or nearer, they came into the zone of action of surface waters, and were entirely, or at least, in part, dissolved away. In this way a sort of "salt level" (analogous to "sea level") was formed, which runs approximately parallel to the earth's surface at the depth stated. Only below this level can we expect to find potash salts.

In some cases the salt is completely removed by dissolution, and all that is left is a subterranean accumulation of gypsum and clay as in certain parts of Hanover, but in many instances only the most soluble constituents, the magnesium chloride, was extracted from the potash salts, thus causing a concentration of the mineral in regard to its most valuable constituent potassium chloride. Such partially extracted zones are found covering many of the potash-salt deposits like a cap (see Fig. 2). They are spoken of as the kainite caps, inasmuch as kainite is their principal constituent. The salt in these zones is commonly called termed posthumous, since it acquired its present form only long after its original deposition.

It may not be amiss to mention certain striking peculiarities of the salts, which add much to the difficulty of the geological investigations of these deposits. It is found almost in all cases that the salt layers are very abundantly thrown into folds and smaller creases to a much greater extent than the strata above and below. The cause of this condition is to be found in the first place in local-pressure effects arising through the chemical processes which have been going on in the mass, and secondly in the extreme plasticity of the salt minerals (rock salt, sylvine, carnallite, etc.), especially at high temperatures. In many places the salt is pressed upward very much like a viscid mass of lava, or like the water color or oil colors from the customary tube containers. This is indicated in Fig. 3 by example taken from Algerian salt deposits. Such effects as these have imparted a thoroughly characteristic structure to most salt desposits, as any one may convince himself by visiting one of the salt mines, for instance, in Hanover. Such a visit will be found most interesting even by those who are not directly interested in geology and the potash beds of the salt industry.

Compound Locomotives and Superheat

EVER since 1876, when M. Anatole Mallet, who, by the way, is still with us, applied the first practical system of compounding to the locomotive, there has been much debate among locomotive engineers as to whether it was worth while to expand the steam twice. Not as to whether economy in steam consumption would result; that was easily and abundantly proved, but whether the economy was worth while at the price of added complexity. The various answers given to this question illustrate the old saw, "many men, many minds," and with the development of the locomotive the problem of compounding has passed through many phases. In the early days the two-cylinder compound gave satisfactory results, though handicapped by the lack of symmetry. With the growth in weight of locomotives the disadvantage of the unequal cylinders became more pronounced and the low-pressure cylinder outgrew the loading gage. Then the four-cylinder compound took its place and was widely used, particularly in France and on those German railways influenced by von Borries. In this country four-cylinder compounds, and also those with three cylinders which possess largely similar advantages, were used somewhat sporadically, for the British locomotive engineers have always shown more than a little individuality in their designs. In America two types of four-cylinder compound locomotive successively flourished and fell away, and now a single expansion of the steam is nearly universal except with Mallet type engines. In Europe at present the phase of the question which is of interest is the combination of compounding and superheating. We do not propose to consider here the thermodynamic side of the problem or to investigate how economy is effected, but merely to note the growing volume of evidence to the effect that steam and coal can be saved by using compound cylinders together with superheated steam.

When superheated steam was first introduced into practical locomotive work by Schmidt the advocates of the hot steam were strongly opposed to the use of compound cylinders. The result was that the success of superheating reduced the use of the double expansion. Now there is a marked movement of return to it. The experience of the Paris-Orleans Railway showed some years ago that where, with saturated steam, compound cylinders effected an economy, the same percentage of economy was maintained if the engines were supplied with superheated steam. M. Marechal, of the Paris, Lyons, and Mediterranean, after extensive study of the types of locomotives to give the best results with superheated steam, has definitely chosen four-cylinder compounds both for goods and passenger service. On the Prussian State Railway the latest design for the heaviest express service is a 4-6-0 type with four compound cylinders using superheated steam, while at a recent meeting of the Institution of Locomotive Engineers one of the speakers said that it was not unlikely that a three-cylinder compound with superheater would be soon seen on an English road. The compound superheater of the Prussian State Railway is particularly interesting in view of the locomotive history of that road. Herr von Borris when in charge of the locomotive department of the Hanover district was a strong advocate of compounding and his name is associated with types of both two and four-cylinder compounds. Even after his premature death, while compounds remained in favor at Hanover, at Berlin opinion leaned to single expansion. On the introduction of superheating, Herr Garbe, in attempting to secure for a two-cylinder single expansion engine the perfect balance of the four-cylinder compound, went so far as to omit all counterbalance for the reciprocating parts. Though the engine and tender were rigidly coupled to oppose the mass of both to the fore-and-aft forces of inertia the attempt was unsuccessful, and now after some years the Hanover school is taking the ascendant and compound locomotives are coming into favor for the most exacting high-speed service. The evidence seems to be conclusive that superheating has not done away with the opportunity for effecting an economy in water and coal by a double expansion of the steam. The question remains, as it always has done. Is the necessary complexity too high a price to pay for the economy? With the increase in the size of locomotives the case for compounding has strengthened. In the largest modern high-speed locomotives there is considerable advantage to be gained by the use of three or four cylinders. By this means the stresses in the driving axle are distributed and reduced and the counterbalancing can be carried out so as to do away with rotating counterbalance weights for the reciprocating parts which in the case of a two-cylinder engine may cause the wheel load at high speeds to vary during each revolution 30 per cent either way from the value it has when the engine is at rest. If these advantages are sufficient to determine the use of more than two cylinders very little additional complexity is involved by compounding the cylinders, and for certain services at least economy in the use of the steam will be obtained. On the other hand, the increased boiler pressure desirable with compound cylinders must not be overlooked, as with bad water this may make an appreciable difference in the cost of boiler maintenance and the advantages which might be gained in that respect by superheating with lower pressure steam, must be foregone.

Like many other complex engineering problems, the question is one of men as well as of a machine, and in many, if not in the majority of cases, the human element will determine the solution. The compound locomotive does not usually make so direct an appeal to the drivers as the superheater engine does, and to secure all possible economy it must be carefully used and maintained. There seems, however, to be evidence that with a reasonably intelligent and well-disciplined force for driving and running shed work the net result of using compound cylinders with superheat proves economical and satisfactory, for certain services at least. What its limitations may be is a subject well worth discussion.—*The Engineer.*

Modern Shoe Polishes and Dressings*

By Dr. J. T. Donald

Dressings.—This term includes all preparations used in cleaning or renovating boots and shoes where friction is not employed, whether the result be a gloss or not.

By far the most important and widely used dressing is "Ladies' dressing," so called because of its very general use on women's and children's foot wear of kid and goat leathers. This is essentially a colored solution of shellac, borax or an alkali being the solvent and nigrosin the coloring agent; a little glycerin is usually added to prevent cracking of the lac and to preserve the softness of the leather. When applied with a sponge, there is left on drying a thin coating of colored shellac having a soft and pleasing gloss.

When a solution of soap is added to "Ladies' dressing," the soap overcomes the gloss of the shellac and the preparation is now "Gun metal dressing." This in the language of the trade "does not dry bright but gives to the article a dull gun-metal finish."

Patent Leather Dressing.—This is usually simply an oil such as olive or cotton-seed under some high-sounding name, or vaseline, or a white wax reduced to a soft paste by means of turpentine. The application of any of these with a soft cloth brightens the gloss of the leather but has no effect upon cracks in the enamel, which are so troublesome in this style of leather.

For these there is a special preparation of guncotton in solution in amyl acetate colored with a spirit-soluble black dye. On the evaporation of the solvent there is left an elastic pad of cotton filling the crack and adhering to the edges.

Nappy Dressing for Use on Ooze, Suede, Nappy and Castor Leathers.—This is wood alcohol having in solution a color insoluble in water. The alcohol cleans the nap of the leather and on evaporation leaves a deposit of coloring matter which, being insoluble in water, does not markedly soil damp garments.

White leather, as in military belts, claims a dressing for itself. The pipe clay of our forefathers is still in use, sometimes alone and sometimes in admixture with light magnesium carbonate. The mixture gives a lighter and more pleasing white than does the clay alone.

Another article is zinc oxide suspended in water containing a small percentage of an adhesive. This is applied by a sponge and in drying leaves a layer of the white pigment. By mixing with the white solids a small percentage of such substances as lampblack, umber, red and yellow ochre, we have preparations for canvas shoes of various colors.

Polishes.—These constitute by far the most important part of the output of a factory both in volume and money value.

The shoe polish almost universally used a generation ago, was made by mixing together some form of bone charcoal, sulphuric acid, neatsfoot or other oil, and molasses or other form of sugar syrup. The carbon imbedded in a paste of sulphate of lime was the chief factor in the polish developed by friction. Modern shoe polishes are prepared along entirely different lines, waxes being the bodies responsible for the polish or gloss.

For ordinary leathers, the requirements of a good shoe polish are, that it shall give a high gloss with a moderate friction, shall not be sticky or hold dust, shall be waterproof, and shall not soil clothing that may come in contact with the shoes.

Carnauba wax with its hardness and high melting point is the basis of modern friction polishes. The cheaper candelilla wax may to a certain extent replace the carnauba with but little difference in the quality of the polish.

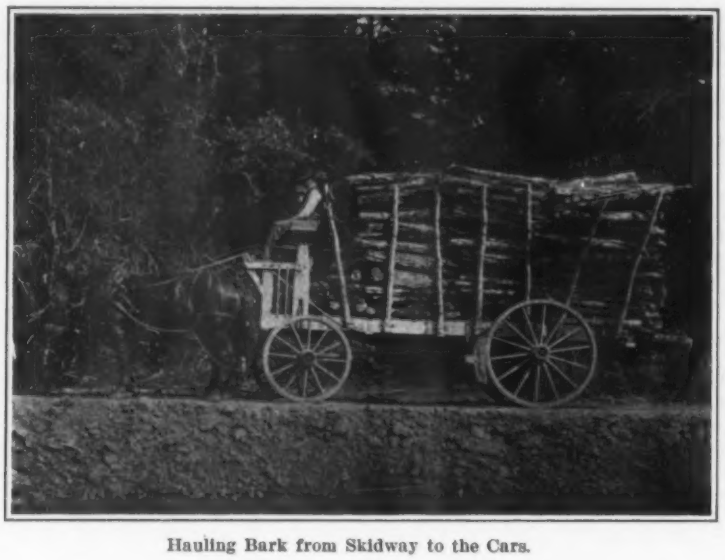
There are two chief methods for working these waxes into polish: The wax is emulsified by boiling a solution of borax. The product is known as white stock. If polish is to be in the form of paste, the white stock while hot is mixed with a hot solution of ordinary laundry soap and sufficient nigrosin to give the desired depth of color. The mixture cools as a soft paste that may readily be applied by means of a brush or sponge. If the polish is desired in the liquid form, the best grade of castile soap is used; a solution of this variety of soap does not gelatinize. Numerous trials have shown that no matter how dilute the soap solution—a satisfactory liquid cannot be obtained unless castile soap is used. Both the paste and liquid forms are widely used. With a moderate friction, the hard waxes held upon the leather by the soap, give a beautiful and very desirable polish.

The second method of dealing with the hard waxes is as follows: Carnauba or candelilla or a mixture of the two with beeswax and ceresin or paraffin is dissolved in hot turpentine and mixed with very finely pulverized bone charcoal. When properly cooled there results a firm paste that spreads rapidly under a brush or sponge. When this mixture is poured into boxes it must be promptly cooled, otherwise there is a separation of the harder waxes from the solvent, the result being a granular sloppy mass instead of the firm paste desired. If the harder waxes alone were used it would be difficult to prevent separation from the turpentine on cooling, hence the admixture of softer waxes. Beeswax gives also a toughness or lack of shortness to the paste and a smooth finish that cannot be obtained without it. These softer waxes reduce the gloss available from the carnauba or candelilla. The use of bone black as a coloring agent is an attempt to overcome the weakness inherent in the use of the softer waxes and to add to the gloss obtainable from the waxes that obtained by friction of the bone carbon.

For tan leathers the same goods are used except that a brown or yellow dye and pigment replace the nigrosin and bone char. The application of the tan polish is frequently preceded by the use of a cleaning solution to remove stains and discoloration.

A popular cleaner is a mucilage of gum tragacanth containing a small percentage of oxalic acid. So remarkable is the power of tragacanth to hold water that this article, in appearance a thick cream, is 97 per cent. water, gum and acid constituting the remainder.

* Paper read before the Society of Chemical Industry, and published in its *Journal*.



Hauling Bark from Skidway to the Cars.

"Bunching" the Bark in Small Piles Along the Road.

Harvesting Tan Bark

And the Problem of Meeting the Demand in the Future

By Prof. Samuel J. Record

THE value of the vegetable tanning materials consumed annually in the leather industry in the United States is approximately $22,000,000. There are six sources of these tannins, namely, (1) gall-nuts, particularly of oak as the result of insect injury; (2) fruits of certain plants, mostly tropical, as acorns and myrobalan nuts; (3) leaves of some trees and shrubs, such as sumac and numerous exotics; (4) wood of such trees as chestnut and quebracho; (5) bark of a great many trees and shrubs, for example, hemlock, oak and mangrove; (6) roots of certain plants.

So far as native materials are concerned the principal sources of tannin are hemlock and oak barks and chestnut wood. Their combined value is about $15,000,000 annually. The remainder is very largely supplied by quebracho extract from Argentina. Quebracho has been widely exploited in the last few years but the supply is limited and the trees are so small and scattered over such large areas that logging operations are becoming very expensive. The bark of this tree contains from six to eight per cent of tannin, and the heartwood from twenty to twenty-five per cent.

The decrease in the usual sources of vegetable tannins is being met in part by introducing new materials and partly by substituting chemicals for them. There appears to be a limit to which substitution can be successfully carried and the question of the future supply of vegetable tannins is becoming a matter of serious consideration. Attention is being directed to the tropics where conditions are most favorable for the formation of tannin. Extensive experiments are under way in India to perfect the method of making commercial tannin extracts from mangrove and other barks. In 1910, 73,355 tons of myrobalan nuts were exported from India for use largely for tanning purposes.

HEMLOCK BARK.

There are two important species of hemlock in this country, one a native of the eastern States, the other belonging to the Pacific coast. The use of the bark of the eastern hemlock for tanning purposes began at an early date and for many years that was the only use for which the tree was employed. Owing to the great abundance of white pine and other woods better suited for lumber, hemlock was not worth sawing and the massive trunks, stripped of their bark, were allowed to rot in the forest. This condition no longer prevails for the wood, though not of high quality, finds a ready sale for construction and many other purposes where the demands are not too exacting.

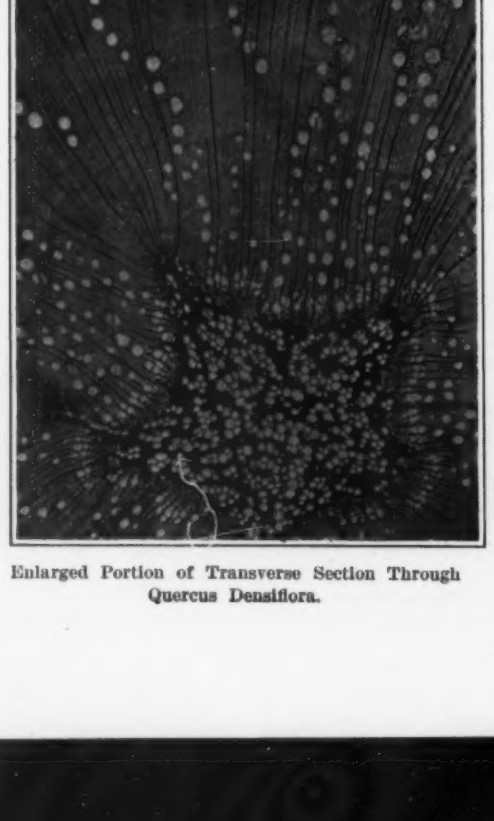
While hemlock bark is a great source of tannin the quantity used is steadily decreasing due to the exhaustion of the forests. The amount of the bark employed in the United States in 1906 was over 930,000 tons; in 1907, 816,000 tons; in 1908, 810,000 tons; in 1909, 698,000 tons. The amount of hemlock extract consumed in 1909 was little more than one fourth of that used in each of the two years preceding. Most of this supply is from the eastern species for while the content of the western form is considerably greater, the latter has only recently been used to any appreciable extent.

The peeling of eastern hemlock bark is conducted only during the growing season when the cambium layer which unites wood and bark is full of sap and tender. The process begins early in May and continues until the latter part of July, the best months being June and July. During the remainder of the year the bark adheres so tightly to the trunk that peeling is impracticable.

A peeling crew is usually composed of four men, known respectively as a fitter, a spudder and two log-cutters. The fitter selects the tree to be felled and with his axe cuts through the bark near the ground entirely round the tree. He then cuts another ring four feet above the first, and splits the bark down one side from ring to ring. The spudder then inserts a tool called a "spud" beneath the bark and peels it off.

The log-cutters now fell the tree and as soon as it is down the fitter girdles the bole in four-foot sections and splits the bark along the entire length. The spudder follows him and peels off the bark in as large pieces as possible to reduce future handling and leans it against the fallen tree to dry. The log-cutters saw the tree into logs ready to be skidded out. Sometimes cutting into

Typical Tanbark Oak Tree, Showing First Four-foot Ring Being Taken Off Before Felling the Tree.



Enlarged Portion of Transverse Section Through Quercus Densiflora.

Crew of Four Men Peeling Hemlock Bark. One Man to Trim Limbs and Knots.

"Peeling." Four-foot Ring Being Taken from Tree.

"Skidway" Along Which the Bark is Sledged from the Woods.

logs is deferred until later in the year and in this case the fitter and spudder comprise a crew. Two men can peel from three to four cords of bark a day.

The time required for the bark to dry out varies from several days to a month, depending on the condition of the weather. As soon as dry it is usually removed, either on wagons or crude sleds. A common form of bark sled used where the ground is not too steep for horses to travel consists of two fifteen-foot birch poles with the rear ends dragging and the front ends supported over short runners. From two to two and a half cords of bark are placed on a sled, bound fast with ropes, and hauled down the hill to the landing.

If the slopes are very steep the bark is often sent down in triangular or rectangular troughs, made in portable sections. The workmen start near the base of the slope, sending all the bark within a short radius of the chute. As the work progresses up the slope new sections are added until the upper limit of the cutting is reached, whereupon the slide is removed and the process repeated on a new route. On very steep pitches the speed of the descending bark is reduced by means of a swinging board under which the bark passes. The friction checks the speed but breaks up the bark rather badly.

The yield of hemlock bark varies with the size of the trees and the locality of growth. It is usually calculated on the basis of the amount of timber cut. In Maine and West Virginia the yield is one cord to from 2,000 to 2,500 board feet of log scale; in Michigan, one cord to 2,000 feet; in New York, one cord to from 1,700 to 2,000 feet; and in Pennsylvania, one cord to from 1,500 to 2,000 feet. Much of this difference is probably due to the methods of scaling practiced in the various regions.

The bark is shipped to tanneries or extract plants where it is stored in sheds or in the open in well constructed piles. The best results are obtained from bark that has been seasoned for a year or more in airy sheds and not exposed to sun or rain.

CHESTNUT OAK BARK.

While the barks of all the oaks are fairly rich in tannin only a few species are highly valued on that account. The best of all the eastern species is the chestnut oak. Though the bark has no greater tannin content than some of the other oaks yet the ease in harvesting and the excellence of the leather it produces give it first rank. The species is fairly well distributed in the eastern part of the country but is most common and of its largest size on the lower slopes of the mountains of the Carolinas and Tennessee where it often forms a large percentage of the forest.

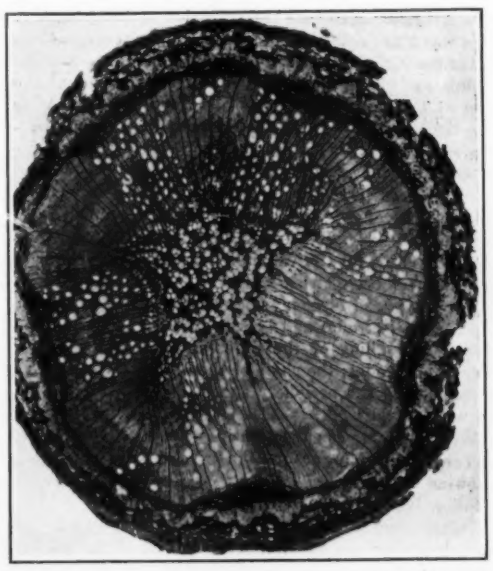
Peeling operations on chestnut oak are conducted from the middle of April to the middle or latter part of June. The methods pursued are much the same as for hemlock. The average yield of bark is one cord from 1,500 board feet of timber.

TANBARK OAK BARK.

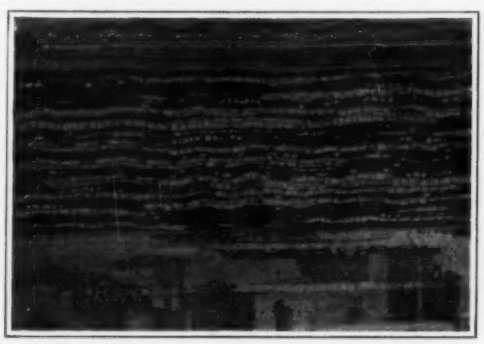
The tanbark oak occupies a position botanically about half way between a chestnut and an oak. So far as the bark is concerned it is an oak and far surpasses all other species in the richness and excellence of its tannin. It occurs in southern Oregon and in California, chiefly in association with redwoods. The wood is held in such low esteem except for fuel that it is customary in most operations to leave the peeled tree trunks on the ground as was formerly the case with hemlock. As in the latter instance, however, the wood of the tanbark oak is gradually coming into use as its great tendency to check and warp is being overcome by proper methods of seasoning and handling.

It is estimated that there are now 1,425,000 cords of standing bark of this species in the Pacific coast forests, of which all but 60,000 cords are in California. At the present rate of consumption this is not sufficient to provide the needs of the valuable leather industry of California for more than forty-five years at the most. Its principal use is in the manufacture of heavy leather designed for belting, harness, saddles, and shoe soles. The total value of the output of California tanneries from the beginning of the industry in 1851 to the present time is over $85,000,000. Nearly a million cords of tanbark oak bark worth $18 a cord has been consumed.

The peeling season for tanbark oak begins about May 20th and lasts until the middle of August, although the best time is during the latter part of the season when the bark is tougher and does not break so readily. Tanbark oak is extremely sensitive to heat and cold as regards the adhesion of its bark. A cold spring delays the opening of the peeling season and a cool, moist summer prolongs it. At least half a day is required for two men to peel a large tree and the peelers, therefore, never begin late in the day upon a tree which they must not leave unfinished until the next morning, as the bark may "bind down" over night. Even the "try marks" on trees which are found not ready to peel interfere with satisfactory work later in the season by making the bark stick.



Transverse Section Through Quercus Densiflora. Two-year-old Twig Showing Tannin.



Radial Section Through Three-year-old Twig of Quercus Densiflora.

The peelers work in pairs and use a single-bitted axe instead of a spud. With the blade of his axe the peeler tries the bark to see if it is loose and if it is he cuts two circles through it, one near the ground, the other four feet above. The bark is then slit longitudinally and taken off in from one to four pieces. The circle of bark thus removed is called a "coil" or a "run." The first coil is removed while the tree is standing because the work is easier and also because it prevents the loss in chips at the base of the tree where the best bark is. The tree is then felled and one man goes ahead "ringing" or cutting through the bark around the trunk at four-foot intervals and the others follow and removes the coils and lay them on the ground to dry with the inner or "flesh" side up. The process is continued up the bole until the bark becomes less than one half inch thick.

Trees down to three inches in diameter are usually peeled and in the case of the smaller sizes one or two coils are removed without cutting the trees. This is called "jayhawking" and is extremely wasteful because the yield per tree is low and good bark which cannot be reached is often left. In some localities "jayhawked" trees are frequent with clear trunks for twenty feet above the last coil taken and bark three quarters of an inch thick. Destroying the young trees also interferes seriously with a second crop of tan bark. Another source of waste occurs in the case of very limby trees where it is a general practice to take the bark off only the clear portion of the trunk and abandon much of the remaining bark even where it is thick.

As the coils of bark become dried they harden and curl up. About three weeks are required for the bark to become dry enough to haul. It is then bunched by hand in small piles to which narrow sled roads are cut for sledding it out to skidways along the wagon roads. From there it is hauled to market or to the railroad on wagons which carry from three to four cords each. In rough places the bark is sometimes packed to the skidways on mules which can carry from 250 to 400 pounds each. After the coils are removed men go through the woods to collect and sack the chips, particularly those from the base of the tree. The average yield of bark is from one and a quarter to two cords per acre with a maximum of eight cords.

The percentage of tannin varies with the part of the tree from which the bark is taken and with the local and geographical situation of the tree. Old bark near the base or "rump" of the tree contains the greatest proportion. The color of the cross section of fresh bark is an index of the quality in this respect, bark richest in tannin being a deep red, while the poorest is pale or yellowish. Bark is not considered "ripe" until it has formed three layers, namely, a rough outer "ross," a central "meat," and an inner "fiber." Before it is so divided the tannin content is low and for this reason shipments are not supposed to include any "paper bark," that is, bark less than half an inch thick.

As the accessible supply of tanbark oak becomes scarcer and more expensive, bark from other species of oak is occasionally mixed with it. This is particularly the case in the southern districts, where the tanbark oak is nearing exhaustion. The bark of the California black oak and the coast live oak possess so high a tannin content that if it alone were an index to tannage value they could compete with tanbark oak. Experience has shown, however, that they cannot be used alone because they do not produce leather of good quality.

The Manufacture of Carbon Disulphide*

Advantages of the Electric Furnace

By Edward R. Taylor

THE radical changes that have been made possible by the use of electricity in chemical industries are well exemplified in the advance in the manufacture of carbon bisulphide during the past thirty-five years. Reports have been made on the progress of this work from time to time.

The old retort method of manufacturing bisulphide of carbon was fraught with many annoyances and disagreeable circumstances. Yet at one time I had as many as twelve of them in running conditions. With but one retort in a place, economies vanish rapidly. With a number in the same furnace they are not all likely to fail at the same time, but one is constantly taking out and putting in, which keeps the works in a state of confusion all the time. Fortunately, the large dynamo, with its ability to generate electricity in large quantities and at reasonable rates, has come to our aid. In any of the usual retorts we are limited as to sizes of retort by possible heat penetration to the interior. As these old retorts are heated externally, you will appreciate some of the difficulties of their operation.

With the electric retort, however, we can have the heat in the interior, where we want it and keep the shell cool; that is the secret of its great success.

In regard to the development of our electric retort, I had considered numerous ways of conducting electricity into the furnace, and gave up as inadvisable the idea of using movable electrodes as is ordinarily done in furnaces. I concluded if I could substitute for that some electrical conductor in small pieces which would come in between stationary electrodes and stand the brunt of the stress, I would overcome the necessity of moving the electrodes, and this has been so successful that we have been able to run our furnace anywhere from eight months to a year without shutting down, and we have made from 1,500,000 to 2,000,000 pounds of carbon bisulphide in a furnace without cleaning out.

Two large induction type dynamos, made by the Stanley Company, are used in producing the electricity to supply our furnace and have given excellent satisfaction. A waterfall and lake furnish regular water-head for the turbine generator. A Corliss engine helps out the water power. Two cables convey the electricity from the dynamos to aluminium bars 6 inches wide and ⅝-inch thick, which are connected with the insulated electrodes. Aluminium is used in preference to copper because it is less liable to corrosion. Careful and absolute insulation from the shell of the furnace is necessary and possible.

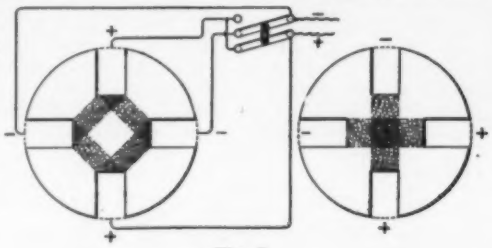


Fig. 2.

Figs. 1 and 3 show the interior construction of the furnace. Each composite electrode in this furnace is composed of twenty-five carbons each 4 inches × 4 inches × 48 inches, making a complete electrode twenty inches square and forty-eight inches long. We use two-phase alternating current and four of these electrodes. In the center of the furnace they are about twelve inches apart. Chimneys above each of these electrodes are used to convey broken carbons down upon them and over their ends. Their action breaks up and diffuse the current which, instead of being of one or two acres, is broken up into a multitude of little ones, but these probably disappear as the furnace heats up. This moderates the intensity of the heat, stops entirely the hissing of the current so common in arc furnaces, and protects from excessive wear the main and more expensive electrodes, which last a year or more without renewal.

They also, if possible, serve a still more important purpose in regulating the current and saving the necessity of moving the eletrodes through the walls of the furnace, which would be a very troublesome thing to do in a furnace filled with melted and vaporizing sulphur. This was a problem that presented very serious features in the early thought of a furnace for this purpose. The broken carbons also relieve the intense violence of the heat at the terminals. It will be appreciated that for low temperature work, like the manufacture of bisulphide of carbon, this is very essential. They also facilitate the starting and stopping of the furnace. Indeed the broken carbons are so valuable in this respect that we find we can stop and start at will, even when the furnace has become completely cold, and I cannot emphasize too highly the value of these broken carbons in a furnace of this construction.

To charge the furnace, sulphur is filled in up to the top of the electrodes and broken carbons are added, including the filling of the different chimneys over the several electrodes; the shaft of the furnace is filled with charcoal, and the periphery spaces of the furnace filled up with sulphur.

With the large construction it is easy to feed the cold and crushed sulphur around the periphery of the furnace, allowing it to find its way in the melted state into the interior heat zone.

Being progressively raised in temperature as it approaches the zone of reaction, the level of the melted sulphur is regulated by the amount of current supplied to the furnace and the amount of cold sulphur fed into the periphery.

On combination of the sulphur vapor with the charcoal, the formed bisulphide of carbon rises through the charcoal above it, heating it as it progresses downward towards the reaction zone.

Thus, in this furnace, the heat seeking to escape by radiation is continuously borne back to the reaction zone by the incoming material.

So complete is this return that, when making bisulphide of carbon at the rate of fourteen thousand pounds per twenty-four hours with the room at 10 deg. Cent., the outside shell of the furnace shows temperatures at different points ranging from 23 to 64 degrees as a maximum; with yet more power in the furnace, the production would be greater and these readings still lower.

There is very little wear to the interior of the furnace. If electrodes are disposed to get very hot, we feed a little more sulphur than otherwise, and that has a tendency to cool the electrodes.

Sometimes pillars are disposed to form in the corners between the electrodes. We use the two-phase current, with one phase put on one side and the other phase on the other. Now, if pillars form in the corners, and the conductivity of the furnace is not just right, we sometimes change over and run the current to adjacent electrodes to burn out the pillars. This change is shown in Fig. 2.

The provision for the sulphur is, I believe, one of the most important features of the furnace structure. We are able to lag the furnace from the inside instead of outside, and we lag it with the very materials used in the production of the carbon bisulphide.

Now the more perfectly we can carry this out, and the more completely full all of these channels can be kept with sulphur, the greater the economy will be in the production of the goods. The real fact is I have never yet been able to put enough current into one of these furnaces to enable us to keep all of these perfectly full. I am looking forward shortly to being able to do that, and I anticipate that I shall be able to produce from 25,000 to 30,000 pounds of carbon bisulphide in one of these furnaces in twenty-four hours. We have already produced 16,000 pounds in twenty-four hours, as it is, but with sufficient power to go into the same furnace, it will practically double the output.

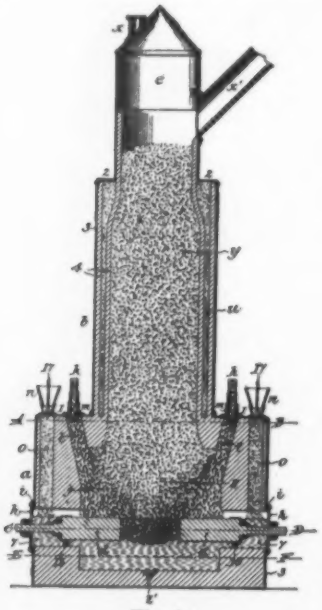


Fig. 1.

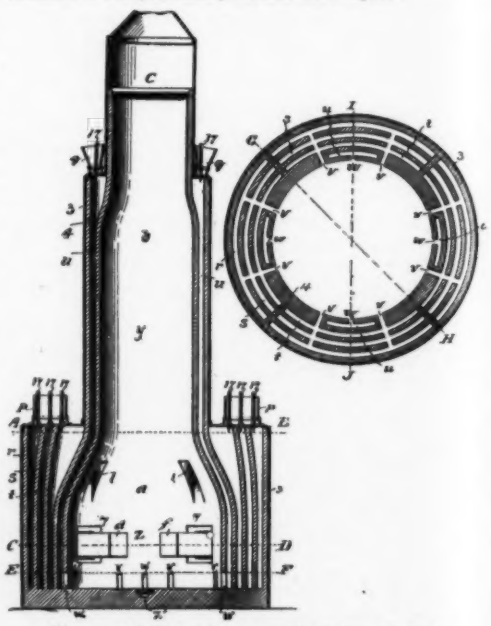


Fig. 3.—Height, 41 feet. Diameter, 16 feet.

* Reproduced from the *Journal of Industrial and Engineering Chemistry*.

Occupational Fatigue

IT is more than probable that few employers of labor follow with sufficient care the discussions which take place before the Royal Institute of Public Health. We cannot blame them, says *The Engineer*. There are now so many scientific bodies whose work demands attention that we can feel no surprise if some of those which appear only to touch the fringe of living industrial subjects are unheeded. But at a time when the entensive methods that the market gardener employs upon cabbages and lettuces are being used on work people by the manufacturer, it is in the highest degree desirable that the evidence of philosophers who are interested in the general well-being and physical improvement of human beings should not be allowed to pass unnoticed by those whom the future will hold responsible for the condition of the men and women of its time. If that appeal is placed on too high a level for manufacturers who, in the face of increasing imposts and competition, find it difficult enough to make works pay even when no more attention is given to the hygiene of their workpeople than the Factory Acts enforce, and even when the highest resources of scientific management and the most perfect equipment are employed, then, at least, the question must be studied on its lower levels, and such employers must ask themselves if their methods are indeed as fruitful as they appear to be. This is not a matter upon which a hasty reply is to be given. The answer is only to be found by careful study extending over a number of years, and it can only be formulated by those who are able to take a broad view of all the circumstances. If, for example, it was found on investigation that intensive management led to the early breakdown of the efficiency of the general body of workpeople, we should have to face the question of how far the well-being of the public must be sacrificed in order to maintain our industrial position in the world. It is now recognized that unremitting hard work, particularly if it is of a monotonous and closely regulated nature, has an undermining influence upon the nervous system, and hence upon the general health of the worker. How far in the interests of our commerce which demands this sacrifice we are justified in making it, and, alternatively, what methods can be employed

for reducing it, are questions of such importance that they must sooner or later be examined by the State.

But until that time comes we ask manufacturers to give their attention to the reports of those who have made a particular study of the effects of occupation upon health and industrial efficiency. Such a one is Sir Thomas Oliver, of Newcastle-on-Tyne, who has spent many years of his life in the examination of diseases peculiar to industries, and who combines a great knowledge of human physiology with a shrewd comprehension of the exigencies and needs of great factories. At the recent congress of the Royal Institute of Public Health he opened a discussion on occupational fatigue, which from every point of view calls for the consideration of the manufacturer on whatever class of products he may be engaged. It has been supposed that the use of machinery in our factories reduces the amount of manual exertion required for the execution of any given piece of work, and that, as a consequence, the artisan suffers less strain. Sir Thomas Oliver does not hold this view, but, on the contrary, thinks that improved machinery is responsible for the fact that men and women are now more easily overcome by fatigue than their forbears. The fact is that what we know as labor-saving machinery does not save the labor of the individual at all. In many cases what it does is precisely the reverse. It enables the workman to expend more labor than he did before, with the result that he is more fatigued. The tool is more efficient than its predecessor, and hence more is got out of it; but, at the same time, more has to be put into it. There are, of course, exceptions, and in a sense it is true that labor is saved. But it is even more true that it is the number of laborers that are saved rather than the labor itself. What is true of the workshop is equally true of the office. The telegraph, the telephone, and the hundred and one things that have increased the output of offices has not decreased the amount of work necessary. Everything has been speeded up; we have altered the scale by which we measure time and output, and the strain is greater, not less, than before. In the office we see the result in the more frequent break-down of young men, and in the workshop we see it in the gradual displacement of the middle-aged and elderly men who are unable to work at the speed demanded by the new conditions. Few managers now take pride in the number of old hands that they have round them. The majority points with pride to the number of bright, active young men it employs. It must not be supposed that because less physical exertion is required in the workshop now than was needed formerly that fatigue is any the less. The girl who sits on a stool for eight or nine hours a day pushing scraps of steel under a punching machine may be more fatigued by her occupation at the end of the day than a blacksmith. Fatigue and lassitude are induced as much by the repetition of a simple mechanical operation as by physical exertion within our powers. The best work can only be done when the mind and the body are fresh, and, as Sir Thomas Oliver pointed out, the quality of the work or the quantity must suffer as soon as the workman begins to tire. It has been found in many works that the output from an eight hours is no less than from a nine hours day. That is because the last hour of the day is never so productive as the earlier hours. The same is true of overtime. All managers know that the efficiency of their men falls off as the number of hours increases. The experiment is now being tried of allowing a short break in the middle of the morning, and it has been found that a few minutes complete relaxation from work, particularly if light food is taken, has a decidedly beneficial effect. Another interesting point is the effect of recreation. In the discussion to which we have referred it was shown that men who were engaged in muscular labor all day lost efficiency if they worked in their gardens in the evenings. In the mining districts it is held that men come to their work unrefreshed in the morning if they have been to picture-palaces and music halls the night before. We often hear severe criticisms of young men who spend their free afternoons watching football matches, and it is said that it would be far better for them to play themselves. The judgment of the man who sits all day at a desk is not to be taken on this point. Youths, miners, for example, who spend the whole week in physical exercise probably do well not to engage in violent exercises at the week-end.

On all these matters we want more light. It is impossible at present to speak with any certainty, because our knowledge is deficient. Opinions are all that can be offered, and opinions are only possible where knowledge is imperfect. Sir Thomas Oliver has done well in calling attention to the problems that occupational fatigue present, but statistics are required to show whether we are doing well or ill in wearing out labor of all kinds at an early age. Then, and not till then, shall we be in a position to inquire whether some different method is desirable or not. If it is shown to be needed we shall be face to face with the far more difficult, possibly insoluble problem, how to arrest the strain and fatigue of modern industries.

Fuel for Oil Engines

Qualities Required

In comparison with its importance for the present and future development of engineering, no subject is so little understood as that of oil fuel. The term oil has been used quite indiscriminately, and when it is considered that the properties of the different grades of fuel oil differ so radically as to render some of them unsuitable for use in oil motors it is easy to see that a more widespread knowledge on the matter would do much to help on the already rapid progress in the utilization of oil as a fuel. Information on the subject is only generalized, with the result that incorrect statements are made which gain wide acceptance owing to their repetition and the absence of any authoritative contradiction.

THE EFFECT OF SULPHUR.

In the early days of the Diesel engine it used to be said that practically any oil would be suitable for its operation, and in the end it is probable that this optimistic statement will be confirmed. Recently, however, much has been written regarding the effect of certain constituents in oil which may be detrimental unless they are first separated out, and in this connection the presence of sulphur has been regarded as particularly serious. How such beliefs arose it is somewhat difficult to say, except that in certain engines which had been working with an oil containing much sulphur, trouble had been experienced, which was at once attributed to this constituent. In almost every case, however, it has been shown that sulphur was not the cause of the difficulties, which could arise only if water were present to allow of the formation of liquid acid. In ordinary Diesel engines therefore sulphur is not to be feared. But the case is somewhat different in the low-compression or semi-Diesel type in which the water drip is employed in the cylinder to give extra power. It is no doubt largely for this reason that fairly light oils which would be considered perfectly satisfactory in semi-Diesel engines have caused trouble owing to the deposits in the cylinders.

In burning oil under boilers for steam raising the presence of sulphur in the fuel even up to about 4 per cent is likewise not to be feared, and this point is now becoming well established; but by no means the same confidence is felt in regard to oil engines, as is proved by the fact that when several tank ships were ordered recently by an oil firm, no motor vessels were included solely because of the doubt expressed regarding the suitability of Diesel engines for running on the available oil, which contained about 3 per cent of sulphur. It was thought that the acid formed would attack the valves of the engines, as well as the cylinders themselves; that would undoubtedly be the case were the liquid acid formed in the cylinders, but it has been proved not to be present.

CRUDE AND RESIDUE OIL.

Much of the misapprehension which has arisen with regard to oil fuel for internal combustion engines has been due to the manner in which the oils are generally and erroneously described. It is common to hear the Diesel engine spoken of as a crude oil motor, whereas crude oil—that is to say oil as it is derived directly from the earth is seldom employed with any engines. It is of course the residual oils which are mainly utilized for Diesel motors, after the lighter grades have been extracted, and indeed it would usually be very false economy to use the fuel in its natural state for such purposes, since the gasoline and paraffin are of much higher relative value. The percentages of the different constituents vary very widely according to the districts from which the oil is obtained, and this is one of the reasons why it is impossible to give an exact idea of the actual supply of oil available throughout the world for any particular purpose. It also explains why it is possible that the supply of gasoline may be insufficient to meet the demand, so that the price may rise continually, while the heavier residual oils and even the intermediate product, paraffin, may become relatively more plentiful and hence cheaper. This is indeed the present tendency, and probably it will shortly become very marked. Before leaving the question it may be well to point out that there are certain oils which contain extremely small percentages of the lighter products, and are mainly used directly as fuel oils without distillation, the Texas and Borneo oils being in this category.

There is one constituent which, if present in oil, is detrimental for almost any use, and that is ash, which is prominent in one or two instances. The effect of ash is to cause scoring, and even a very small proportion, under one half per cent, is sufficient to give rise to much trouble. Asphalt is also undesirable and should be got rid of before oil containing it in any appreciable quantity is employed.

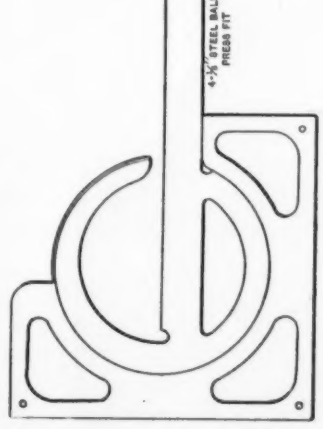
TYPICAL ENGINES AND THEIR FUELS.

Internal combustion engines using liquid fuel may roughly be divided into four classes: 1, gasoline motors; 2, paraffin motors; 3, semi-Diesel motors; 4, Diesel motors. The fuels for gasoline and paraffin engines are more or less clearly defined, while in Diesel motors little consideration has to be paid to the composition of the oil apart from the ash and asphalt mentioned above. It is, however, with the semi-Diesel type that most circumspection is required, for in spite of the fact that all the many varieties work upon the same principle the fuels which may be employed differ considerably. Speaking generally, it is advisable to have an oil slightly lighter than is employed in the pure Diesel engine, gas oil being commonly adopted. The presence of a large percentage of sulphur is to be guarded against, and although some of the motors run on oil with a specific gravity approaching unity, such oil is not to be recommended unless the actual motor to be employed has shown satisfactory operation with it for a long period. It is often found that the claims of a particular engine to run on a specially heavy oil are based on the fact that it has worked satisfactorily with this fuel when used intermittently with another and lighter oil. It generally happens, however, that a semi-Diesel engine which works continuously with fuel having a specific gravity of over 0.9 requires very frequent cleaning, which to a large extent nullifies the advantage gained by the employment of a cheaper grade. This point is of particular importance in considering the question from a marine point of view, where long continuous use is often essential and where a stoppage for cleaning may be of much more importance than a comparatively small economy in the fuel bill.

Until some more definite standardization of fuels other than paraffin and gasoline is adopted there will always be some doubt surrounding the question of fuel oils, but it appears that some harm has been done to the oil engine industry by the existence of the present misapprehension. Greater publicity regarding the experiences of makers and users with any particular oil would be of great benefit generally and would do much to satisfy prospective users of oil motors who at present hear many conflicting reports, all made in good faith.—*London Times.*

To Raise a Draftsman's Protractor.

To prevent the soiling of drawings by sliding the protractor repeatedly over them, Mr. George L Merrill of *Detroit Press* fits four steel balls into the protractor as shown in the sketch. These balls are ⅛-inch diameter and project equally on each side. The instrument is thus mounted on four feet, which keep it clear of the drawing but do not affect its accuracy.

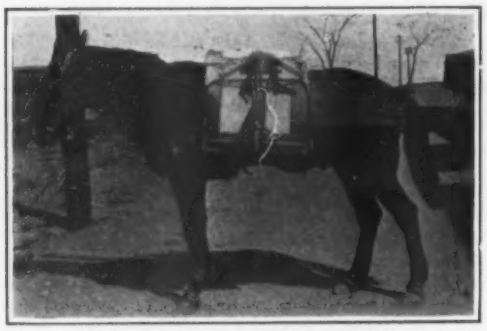


To Raise a Draftsman's Protractor.

The Humanitarian Side of War

Red Cross Sanitary Equipment for the Field

By W. J. Murray



Litter Carrier in Place on Mule's Aparejo. Cinch and Lashing Ropes in Place.

The Litter Strapped on the Mule, and the Patient to Litter.

AT the International Red Cross Conference held at Washington, D. C., in May last, it was proposed by the Hungarian Red Cross Society that it was desirable and necessary that there should be an ideal, and up-to-date, sanitary equipment in the sphere of activity of the Red Cross, in time of war. Ever since the year 1860 when the genius of Lord Lister first "seized" (to use his own words) on the discoveries of Pasteur, and applied them to surgery with such brilliant and complete success, a steady progress has been, happily, maintained in the development of the principles and practice of antiseptic surgery, throughout the whole civilized world.

Having convinced himself of the truth of the germ theory of putrefaction, Lister at once set about finding the best method of preventing the harmful bacteria from gaining admission to the wound, at any stage from its origin to its final healing. In the case of wounds received in battle, as well as through ordinary accidents, Lister recommended the immediate application of a solution of carbolic acid as the most powerful germicide. This is what is known as antiseptic treatment. In the case of regular surgical operations, however, Lister's method was also to prevent the approach of the septic germs by disinfecting everything likely to come into contact with the patient, such as the hands, fingers, and instruments of the surgeon and his assistants. In fact his idea was to have everything surgically clean. This is called aseptic treatment.

While increasing labor and thought have been freely expended on the development of Lister's principles and their practical application, vast improvements are being constantly made in the way of surgical appurtenances, both in the hospital and on the field of battle; which at once secure more complete efficiency in surgical work, as well as greater comfort and safety for the patient.

Among the most recent inventions and improvements in this direction we will here briefly present a number of typical examples which have been found to give every satisfaction in practice.

1. THE REGGENBACH ROLLING LITTER.

Major Reggenbach, of the Swiss Sanitary Corps, has invented a novel-wheeled litter for which a prize has been awarded by the Red Cross Society of Geneva. This litter is provided with a number of adjustable joints of ingenious construction, by means of which it can be adapted, easily and quickly, to a great many uses; and as it weighs only 44 pounds it can be carried on the back by one man, even on a long march. The frame is constructed of seamless steel tubes connected by autogenous welding at the fixed joints. The axle is of solid steel, which is also used to reinforce the curved parts of the handle bars, which rest on the ground when the litter is employed as a sledge. The wheels are made entirely of steel, and have solid rubber tires. The adjustable joints are made of sheet steel with serrated edges, which interlock and keep the joint rigid, when the nut carried by one part is screwed down tight on the bolt carried by the other part. When the nut is unscrewed a few turns the parts are disengaged by the pressure of a spiral spring surrounding the bolt. The parts can then be turned to any desired relative position, and secured therein by screwing down the nut.

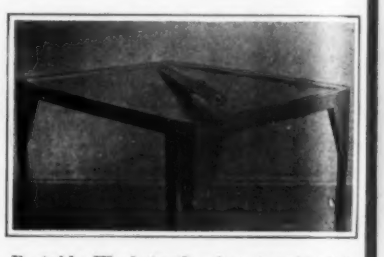
In actual use the parts are never wholly separated as they are shown in the illustration, and, loss of the nut is prevented by a linch-pin riveted to the end of the screw-bolt, and, as the nut is of bronze it cannot become fastened to the bolt by rust. The canvas bed is supported by suspenders of doubled canvas terminating in leather straps which are buckled to the sides of the frame so tightly that the bed, even when occupied, cannot touch the steel traverses. The bed and its occupant are protected from soiling by removable canvas-wheel guards. The Reggenbach litter was devised for two purposes: to provide sick and wounded troops with prompt, safe, and comfortable transport to the rear; and to lighten the labor, and increase the efficiency of the sanitary corps. Recent wars have proved that a litter carried by two erect bearers offers far too large a mark to get safely out of range of the enemy's fire. A Riggenbach litter employed as a sledge, and drawn or pushed by one man, or two men, creeping, would have a very much better chance of escape. The runners can be set higher or lower according to the grade, so as to keep the bed nearly horizontal. Outside the range of fire the litter would preferably be employed as a rolling litter or cart, in which the occupant can either lie or sit. It can be drawn or pushed by a man, or two men, or attached, by its curved handle, back behind any convenient vehicle. Straps are provided, by which a number of litters used as sledges or carts, can be connected so as to form a train which can be drawn by a horse or a few men. For use in deep, soft snow, the sledge litter can be mounted on skis, each attached beneath the runner and wheel of one side. By setting the ends in line with the body, the litter is converted into an ordinary hand litter for use on soft ground.

The litter can also be arranged in the form of a chair in which a comfortably-seated patient can be carried up and down stairs, and very steep hills, by two bearers. In its cart and sledge forms, finally, the litter can be made very useful for the transportation of hospital supplies, guns and knapsacks of men fatigued by a long march, and other material. With regard to the second object of the invention, it is evident that the creeping rescuers are much less exposed to the enemy's fire than the erect bearers. Furthermore, relays of bearers are not needed, as two men can haul the loaded rolling litter for miles. On long marches, and in going into action the litter is folded and carried on the beds. It can even be arranged as a grade for carrying material in mountainous regions.

Litter Used as a Chair, in Stair Climbing.

Rolling Litter Operated by Two Men.

Reggenbach Litter. Used as a Hand Litter.

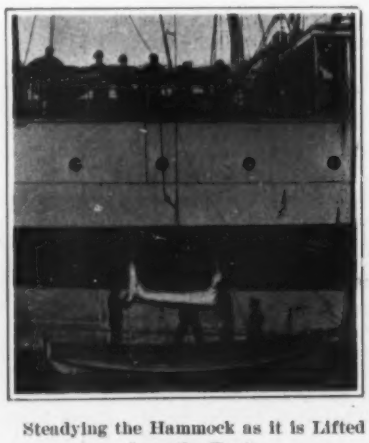


Portable Washstand. One Leg Folded Over Top to Show Construction.

2. THE ABBAMONDI-ROSELLI STRETCHER.

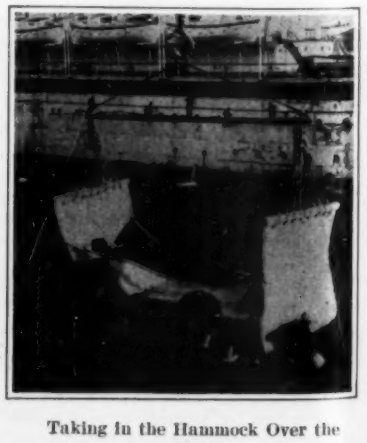
This stretcher consists of a rectangular frame of wood having 1 meter and 77 centimeters of length, and 60 centimeters of breadth, with four linen bracelets at the four corners. A strong linen is fixed internally all along the frame, having sideways several button-holes in which we let pass a string which fixes it to the frame. In the posterior part of the linen, two other sheets of the same strong linen, that we should call aprons, are firmly sewed, and provided also with button-holes and string; they are of a trapezoid form, comprehensively large in their superior part of 1 meter, 46 centimeters, in their central part of 1 meter, 38 centimeters, and in their inferior part (the one which corresponds to the feet of the patient) of 1 meter, 29 centimeters. They occupy almost the length

Preparing to Hoist a Patient Aboard Ship.



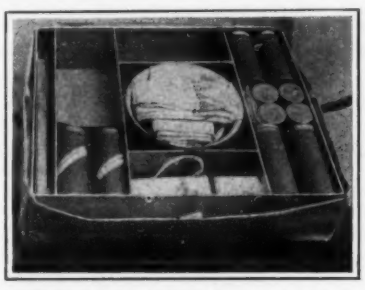
Steadying the Hammock as it is Lifted from the Boat.

In Hoisting, the Hammock Maintains a Horizontal Position.



Taking in the Hammock Over the Rail.

Indicates Ordinary Load on Top of Litter Carrier.



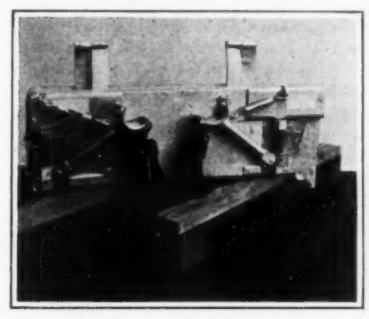
Portable Washstand. Cover Off, Shows Corners of Top and Compartments in Box.

Portable Washstand Packed and in Canvas Case.

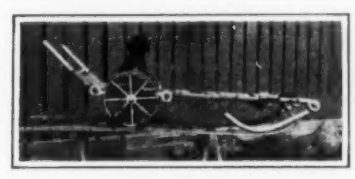
Litter Carrier. Showing Litter in Place and Strapped on.

Portable Washstand Set-up for Use. Box Cover Lid in Background.

Folded for Transportation. Man Acting as a Pack.



Carrier Arms Folded Flat. Halves Hinged Together for Storage, Etc.



Litter Used as a Sledge Mounted on Skis.

of three fourths of the frame; so that when they are fastened together they leave uncovered only the head and the feet of the patient. For greater security, the frame has been provided with a rather thick linen band, sewed to the supporting linen; and with two buckles sewed sideways to the same linen. After having laid the patient on the stretcher we clasp the end of the band to the two buckles, and in this way he will remain with legs across the point where the band is fixed, and he will find thence a point of support whatever may happen to be the position of the stretcher. The two aprons strongly fastened together will not only effectually co-operate with the function of the above-mentioned band, but also assure immobility of the patient, whether we give to the stretcher a vertical, an oblique, or a lateral direction. The Abbamondi and Roselli stretcher has been employed during the actual Turko-Italian war, even for the embarking and disembarking of the patients, placing it in an appropriate hammock. The result has been very satisfactory, especially as regards the rapidity with which the embarking and disembarking were carried out. We may mention that Signor Abbamondi holds the rank of surgeon-captain in the Italian army.

3. A SURGEON'S PORTABLE WASHSTAND FOR USE IN WAR.

This washstand is the invention and design of Capt. H. L. Brown of the United States Army, for which he has won the Red Cross prize of $500, in competition at Washington, D. C., and is intended for use in all the medical units of an army in the field. It may be carried by all methods of transportation, especially by pack mules. The washstand is a telescope box about 24×20×6 inches. The top, or cover, forms the washstand top, and is supported on detachable legs, adjustable to suit uneven ground. The box is divided into convenient compartments, to hold the necessary basins, measures, brushes, disinfectants, towels, aprons, rubber gloves, etc., for the complete preparation of the surgeon's equipment for operating, etc., without recourse to any other unit. The box also holds the legs, and reserve surgical dressing, etc. When packed, the washstand is contained in a canvas case, which protects the contents of the box when the stand is set up. The washstand can be quickly set up, or packed; and has a wide range of usefulness in the sanitary service of armies.

4. A CARRIER FOR LITTERS ON PACK MULES.

This carrier, which is also the work of Capt. H. L. Brown, is designed to hold any type of litter usable by armies in the field. It is used with the United States army pack mule aparejo. The carrier consists of two halves, or side bars, hinged together laterally, which fit over the aparejo like a saddle. Attached at both ends of each side or half, are adjustable arms with "U"-shaped ends, to receive the litter poles. When in place, the litter is strapped to the arms. These arms can be adjusted to suit the width of the litter. When not in use, the arms are folded flat on their side bars, and the mule is then available for general cargo carrying, without removing the carrier. The carrier is fastened to the aparejo by means of a cargo cinch passed over the side bars, or halves; and rope lashings that pass over broad hooks provided for that purpose at each lower corner of the side bars. The carrier holds the litter absolutely rigid, balances the weight, and does not allow the litter to tip up and down as the mule walks along.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Criterion of Patentable Invention

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

Is only structure to be considered in determining the patentability of a machine, manufacture or composition of matter? Or, may new and different results following small changes in structure amount to patentable invention?

Some Patent Office examiners appear to look only to structure. New and different results attending small structural changes are neglected. It is believed that such a course is not consonant with the modern liberal interpretation of our patent law. It seems wrong in principle and surely tends to discourage advancement in the mechanical arts.

These questions as to the proper criterion of invention arise where an old device is put to a new use and adaptation for such new use is necessary. In such cases, it is thought, that the inventive act consists of two parts: (1) The perception of the possibility of the adaptability of an old device or machine to a new use; (2) the actual mechanical working out of such adaptation. It seems that both of these parts ought to be looked to in determining whether the inventive faculty has been exercised.

The "structure only" doctrine looks only to the means employed in the adaptation. The mental act in discovering the old device that may be adapted to the new purpose is neglected. This doctrine is probably supported by the dictum of the decision of Aaron v. Manhattan Railway Company, 132 U. S., 84. This case involved the validity of a patent for gates for elevated trains operated through levers by the gate-man standing between two cars. Justice Blatchford said:

"The patentee is entitled to the merit of being the first to conceive of the convenience and utility of a gate opening and closing mechanism which could be operated efficiently by an attendant in the new situation. His right to a patent, however, must rest upon the novelty of the means he contrives to carry his idea into practical application."

The claims of the patent were held not to exhibit patentable novelty. The prior art showed almost identical arrangements of levers for lifting transoms and for operating shutters. However, the "idea," that is, the application was not broadly new, for rear doors of street cars had been opened and closed from the front platform. The above quoted statement was, therefore, hardly necessary to the decison.

Knapp v. Morse, 150 U. S., 221, also supports the "structure only" test for patentability. In that case a dress-form patent was held invalid, because the adjustability of the form was secured by ribs and double braces fastened to sliding blocks which differed from these members in an umbrella only in changes necessary for adaptability. Justice Jackson said:

"The validity of the patent in question must be ascertained, not from a consideration of the purposes sought to be accomplished, but of the means pointed out for the attainment thereof, and if such means, adapted to effect the desired results, do not involve invention, they can derive no aid or support from the end which was sought to be secured."

This statement was not necessary to the decision of the case, as the prior art contained an adjustable form for the manufacture of hoop skirts which contained all the elements of the patent except a double brace. The double brace was shown in a corset-exhibitor but in a slightly different (the parts being reversed) form.

This decision contained the dissent of Shiras and Brown, *J. J.* The dissent of the latter is believed to be the initiation, in the United States Supreme Court, of the more liberal doctrine.

The later case of Potts v. Creager, 155 U. S., 597, involved a clay-disintegrator which comprised a roll with a plurality of blades set longitudinally in the periphery in combination with a smooth roll set parallel with and close to the bladed roll. This disentegrator had been far

more successful in mixing stratified clay and making it homogeneous than clay-grinders or the soaking process. The prior art included a number of machines, such as paper-pulp machines, five different grinding machines, a cotton-seed huller, a clay-pulverizer and a wood-polishing machine. Several of these patents showed a cylinder with blades set longitudinally and hence anticipated the claims except as to the smooth cylinder, but the court said that the employment of two rollers co-operating together was so common that it could take judicial notice of it. This patent was sustained because not one of the rollers shown in the prior art was adapated for disintegrating clay, Justice Brown stating:

"The person who has taken his device, and by improvements thereon, has adated it to a different industry, may draw to himself the quality of inventor."

Hobbs v. Beach, 180 U. S., 383, reached the Supreme Court in 1900. The patent involved a machine for pasting the stay strips on the corners of paper boxes. It differed from an addressing machine of the prior art substantially only in using an anvil with diverging faces and a notched plunger to descend upon the anvil. It was argued this change would not amount to invention, but the court sustained the patent. Justice Brown saying:

". . . . it is apparent that the mere change in the shape of the dies was a minor part of the work involved in so changing the Dennis and York machine as to make it perform a wholly different function, the invention consisting rather in the *idea* that such change could be made than in making the necessary mechanical alterations."

It is believed that the "idea"—the perception of a new and non-analogous use for an old thing is invention, but the thing not being new is not patentable under our system of claiming invention. The question of whether a double-use may or may not ever be patentable is a perplexed one which is avoided here. But the writer does wish to emphasize, what he believes, is the law as established by the two cases, Potts v. Craeger and Hobbs v. Beach, namely, small structural changes are sufficient to support a patent when a device has been imported from a non-analogous art and is used to accomplish a new and different result.

There are numerous cases of the District Federal Courts and the Circuit Courts of Appeals which bear on these questions, but I believe that the above ones are the controlling ones.

Detroit, Mich. STUART C. BARNES.

The Sanitary Sleeping Car

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

I read with great interest the letter on this subject from Mr. F. W. Fitzpatrick, which appeared in your issue of June 7th, 1913.

His letter dealt with some of the worst features of the ordinary Pullman sleeper and his suggestions for improvement—particularly with regard to ventilation—leave little to be added.

Many letters and much missionary work will be necessary before public opinion forces the railways and the Pullman Company to supply sleeping accommodation in keeping with the ideas of a traveled and critical public, and the following suggestions, mostly relative to minor details, are simply made in the hope that they may induce more effective pens than mine to take up the question through your columns.

In the first place, we must recognize the probability that there will always be two distinct types of sleeping cars in use.

Where the traffic conditions permit, i e., on overnight journeys between important points, the compartment car of the English or Continental (wagon-lit) type will find greater favor as time goes on, the traveling public realizing fully the privacy and advantages of other kinds arising from the compartment system. English cars of this type, mainly divided up into single berth compartments, and the Continental type with fixed upper and lower berths, provide sleeping accommodation superior in every way to the standard Pullman.

In such cars as these the control of light, heat, and air supply in each compartment rests entirely with the occupant (at any rate it is so in England), but in American compartment cars as built at present, the heat is not controllable by the passenger, and the ventilation only partly so.

For long journeys, however, where the car must serve by day as well as by night, and more particularly in view of the preferences of the American public for a car open from end to end, some improved form of the present standard type must be widely used for a long time to come. The heating and ventilation of these cars (apart from the drawing rooms) must remain under a central control, and we must content ourselves with the best results obtainable under that scheme.

But some better arrangement of radiation surface must be found.

Most of us have known the misery of a night rendered sleepless by a furnace heat under ones head (or feet as the case might be) and ones helplessness in the matter does not improve things. The situation, too, is usually made worse by the lack of fresh air.

As regards the heating of compartments it has been said, *ad nauseam*, that independent heat control is impossible owing to frost. In an absolute sense this may be so, but it can be made controllable within wide limits.

With cars steam heated as at present there must be at least one pipe running the full length of the car, and the straight six feet or so of this pipe in each compartment would be the minimum radiator surface possible with the heat turned on throughout the car. The maximum (and adjustable) amount would be the extra surface of a small radiator of some sort, additional to this through-pipe, and supplied from it.

In support of Mr. Fitzpatrick's suggestions as to ventilation, one has only to instance the very perfect supply of fresh air delivered to the inner lower deck cabins of such modern ships as the Lusitania and Mauretania.

As to the berths it need hardly be pointed out that a well-aired standing cot is a fresher and more wholesome arrangement than the usual Pullman berth (the bedding for which is stowed away in a hermetically sealed upper berth during the day) and some more suitable scheme than this latter will have to be devised.

The present curtain arrangements are extremely objectionable. In years gone by it will be remembered that the Pullman Company always had separate curtains for the upper and lower berths, so that the occupant of one need never disturb the other in getting into or out of his berth, and where women are concerned a clumsy variation of this arrangement is still in force; where the occupants of both berths are men one pair of long curtains only is now considered sufficient. As one result of this delightful labor-saving arrangement, it is now impossible in either berth to open the curtains a little for the sake of air in hot weather or when the car is stuffy.

Perhaps in other respects most fault may be found with the lavatory arrangements. The present form of basin might with advantage be abandoned in favor of a simple tip-up (ship-board) pattern, capable of being lifted out for cleaning, requiring no drain plug (of doubtful cleanliness), and free from the usual unpleasant overhanging rim, apparently designed to collect, as well as to suggest, dirt. The hot- and cold-water taps should project quite clear over the edge of the basin, and it might not be difficult to devise a really practicable shelf over each, big enough to hold toilet things—and keep them dry. The provision of a special metal basin at which to cleanse one's teeth was a good idea but why not make them "man's size." They are much too low and the bowl should be as large as the wash basins. It really requires two hands to maneuver tooth brush and tumbler on an unsteady car, and a foot control for the little rinsing jet would not be amiss. Speaking of this, has it ever dawned upon the designer of these cars that some people cannot use cold water (ice water in winter!) for their teeth, and should not need to with hot water available. There is no hot-water tap on the apparatus and for obvious reasons one does not care to fill one's glass at the wash basins.

There are many small points, not connected with the sanitary side of things, which would add to the comfort of passengers, but the list is long and they will come in time. Here are a few: More, and more effective, clothes hooks in berths; more sensible placing of electric reading lights; seats designed with a little more regard to the requirements of human anatomy; and shades to shield the eyes of unfortunates in adjacent upper berths when the powerful ceiling lights are turned on in the dead of night. Porters are not especially considerate.

Some better arrangement, by the way, might be made for the sleeping accommodation of the said porter, who has small chance of rest when the smoking room is used by wakeful passengers.

It is only fair to acknowledge that some improvements have been made of late years, latest among them the sanitary drinking cups (though this was forced from the outside) and the modern steel car is, constructively speaking, far more sanitary than the richly carved and decorated wooden sleeper of by-gone years.

A friend of mine expresses the ideal pretty closely as "a car which could be thoroughly cleaned by the application of a garden hose." This is exaggeration of course, but contains a great deal of truth, and the simple construction of to-day, with some advances in the directions indicated by Mr. Fitzpatrick, would go far toward the realization of the ideal "hygienic, comfortable and desirable abiding place" in the form of a sleeping car.

A READER.

Tables of Cubes

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

Will you please tell me how Mr. J. G. Witton in his article on preparing tables of cubes gets the numbers 48, 54, 60, and 66 in the first and 168, 216, 264, 312 in the second, and 240, 390, 480, 600 in the third. In the SCIENTIFIC AMERICAN SUPPLEMENT of May 17th, 1913, this is the only part I do not understand.

[As stated by Mr. Witton the figures in question are in arithmetical progression, namely:

48=6 × 8
54=6 × 9
60=6 ×10
66=6 ×11

Again,

168=24× 7
216=24× 9
etc.

240=120×2
360=120×3
etc.

—EDITOR.]

Proposed American Engineering Association

IN a paper read before the American Institute of Electrical Engineers W. McClellan proposed the formation of an engineering association, the members of which should be representatives elected annually from each of the existing national engineering associations. The function of the proposed association would be to provide that unity of purpose and interests which is apt to be lacking so long as each department of engineering is taken care of by a separate organization.

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